FEBRUARY 17, 1961

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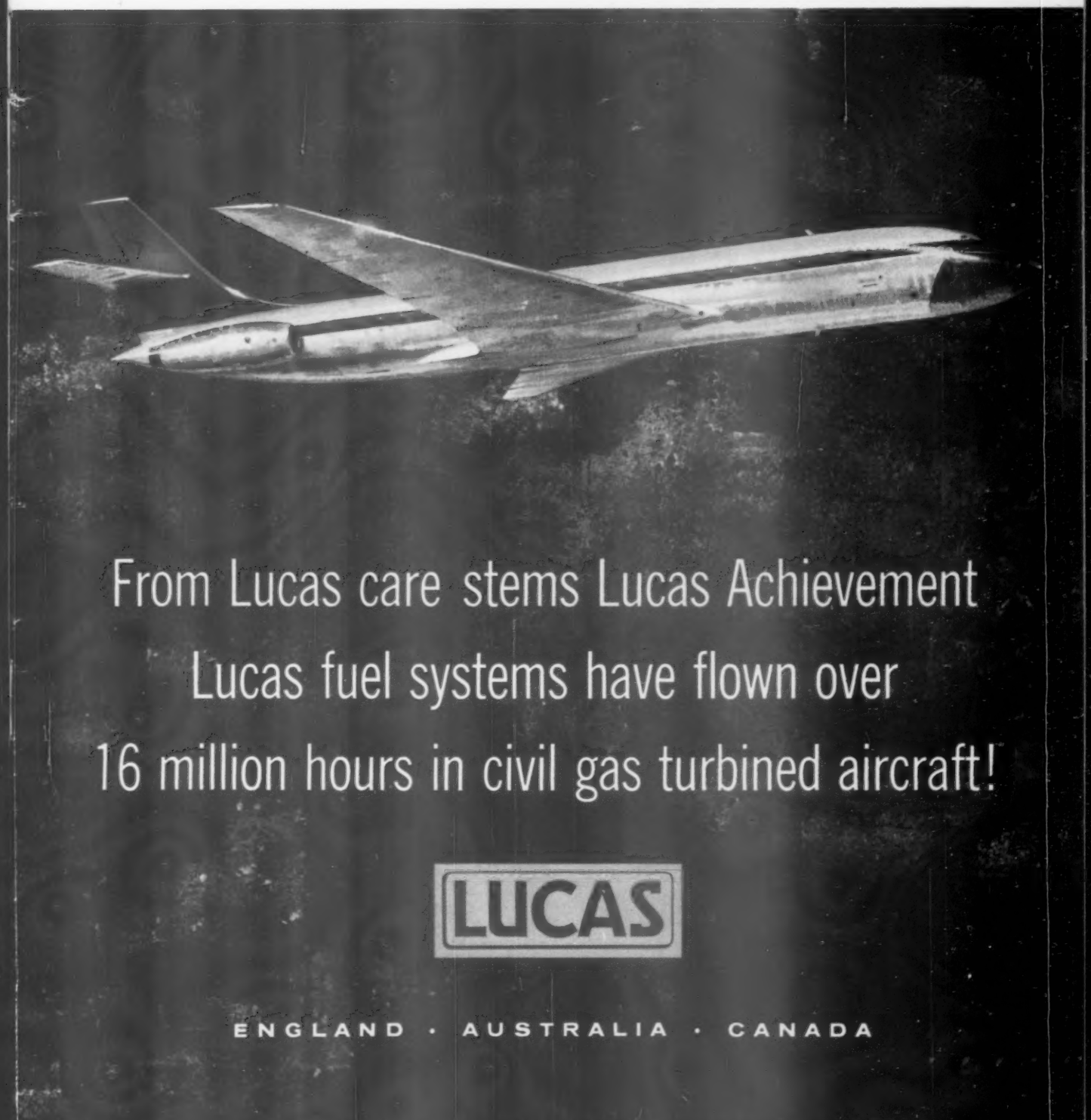
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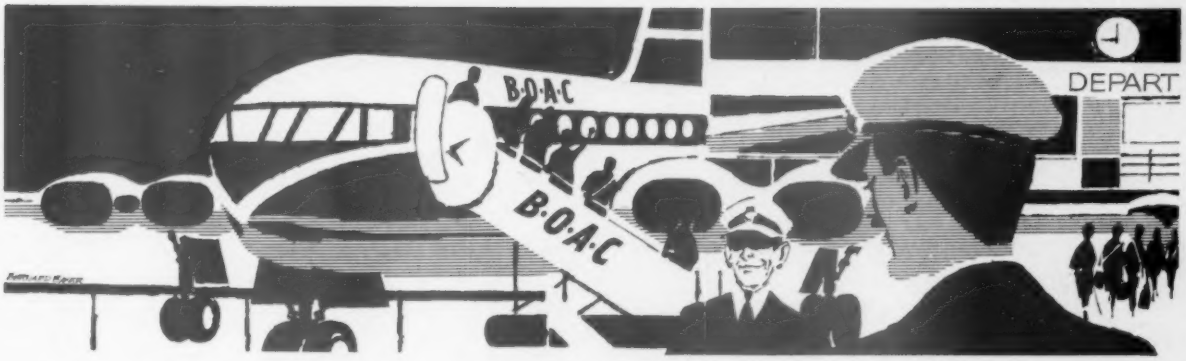

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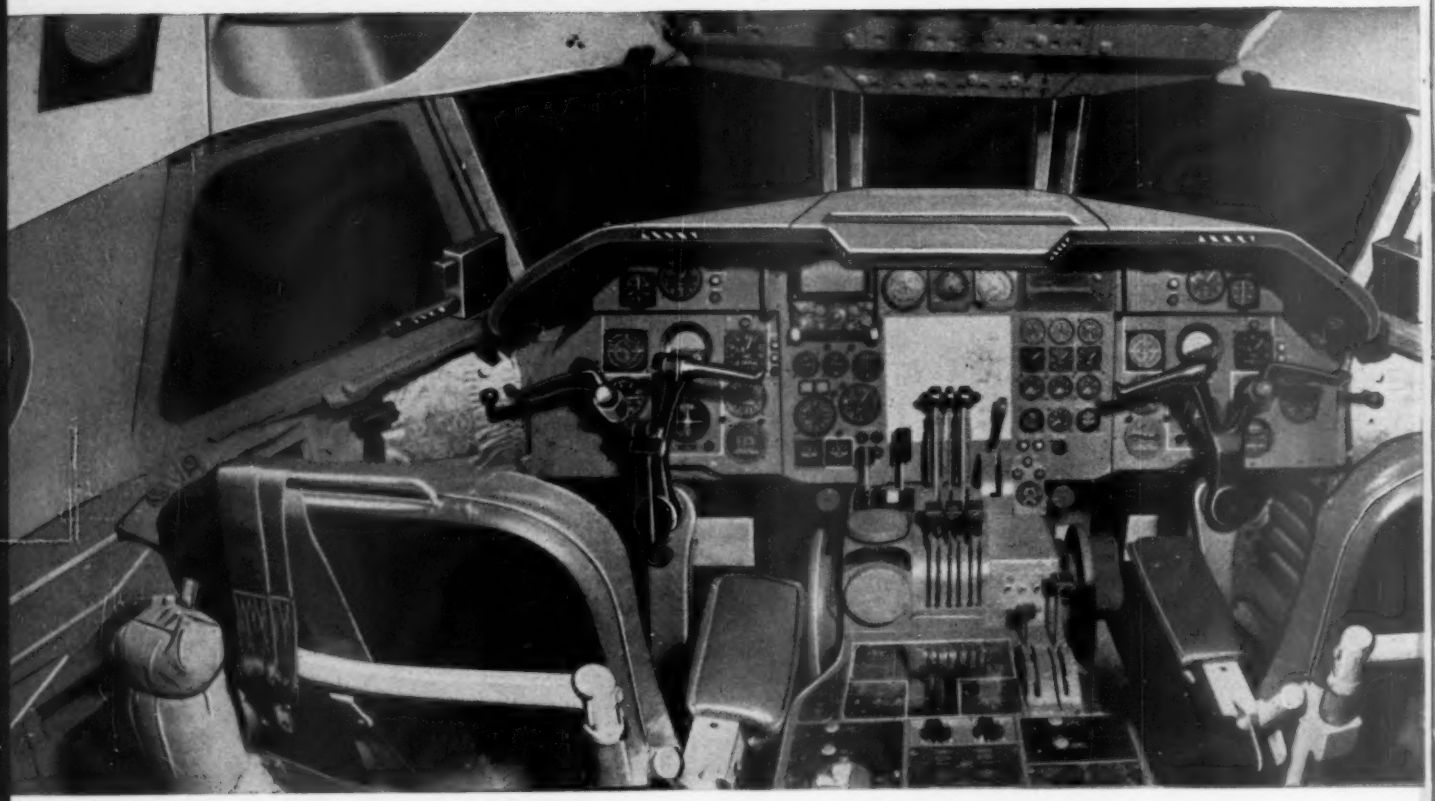

This is a mock-up of the BEA de Havilland Trident cockpit. Smiths equipment has been specified to provide automatic flare control when the aircraft enters service. Smiths S.E.P.5 automatic pilot (the pilot's controller is in the bottom centre of the picture) operates on the Multiplex principle and will, ultimately, provide full automatic landing facilities to civil safety standards. Smiths Para Visual Director (P.V.D.), a revolutionary flight director display, can be seen around the panel coamings. In the D.H. Trident, Smiths P.V.D. will operate in conjunction with the new Smiths integrated Flight System, specifically designed in conjunction with BEA to fit the Trident's operational role.

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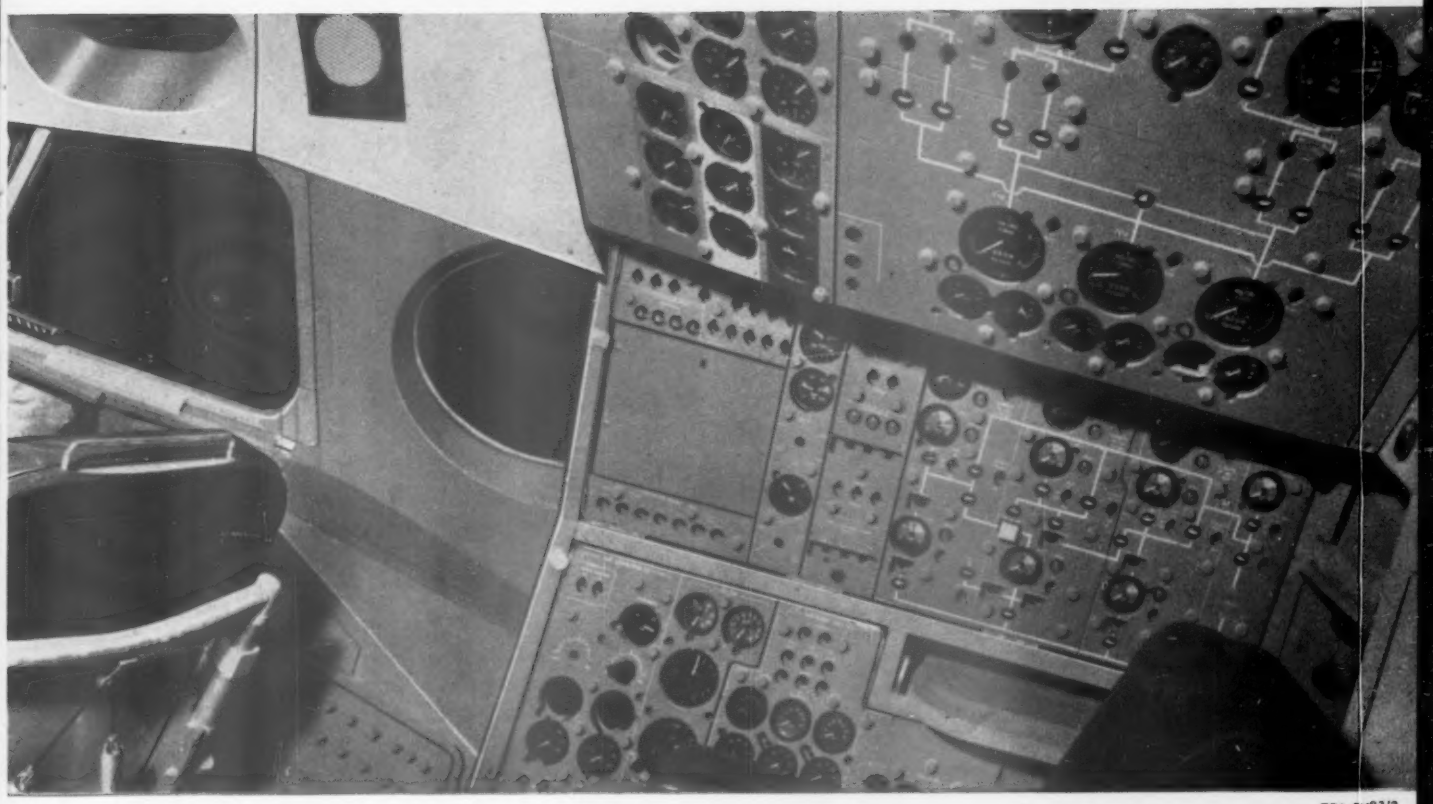

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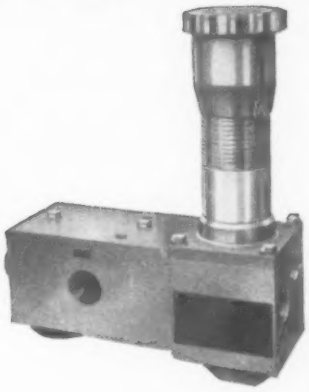

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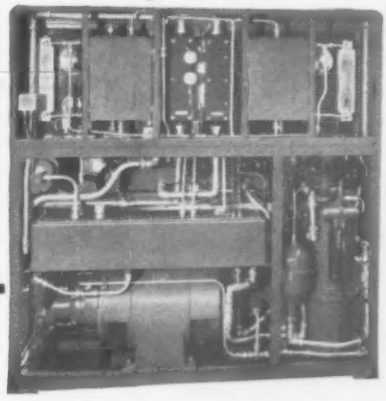

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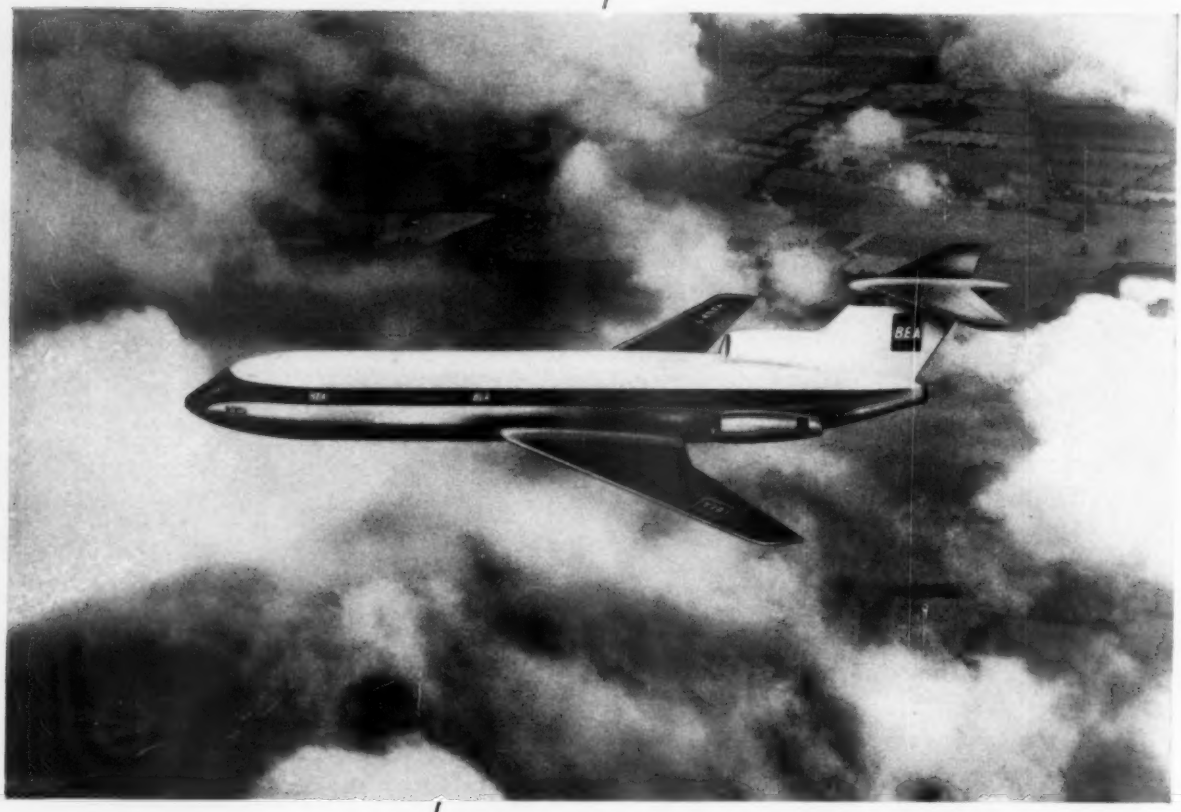

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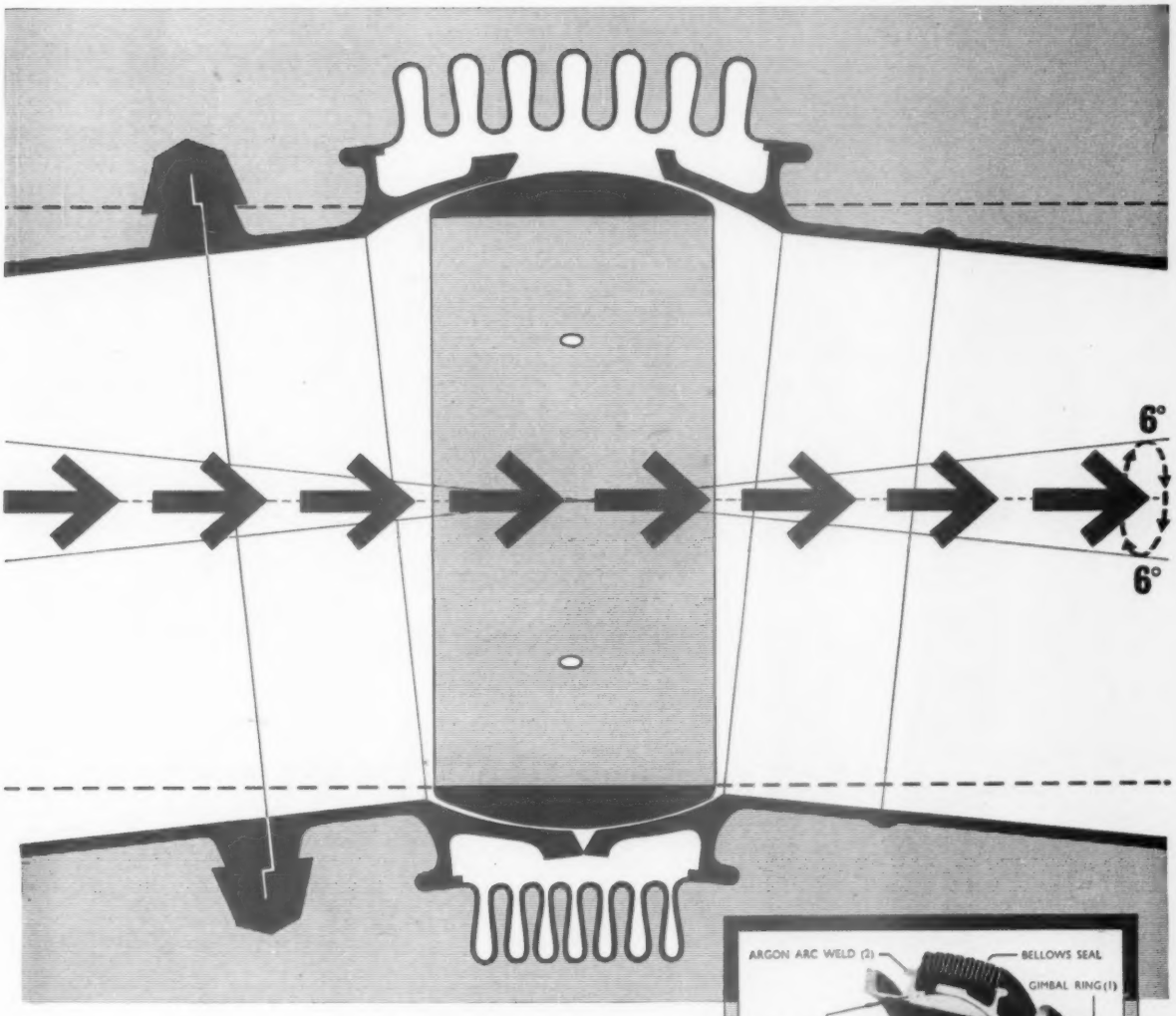

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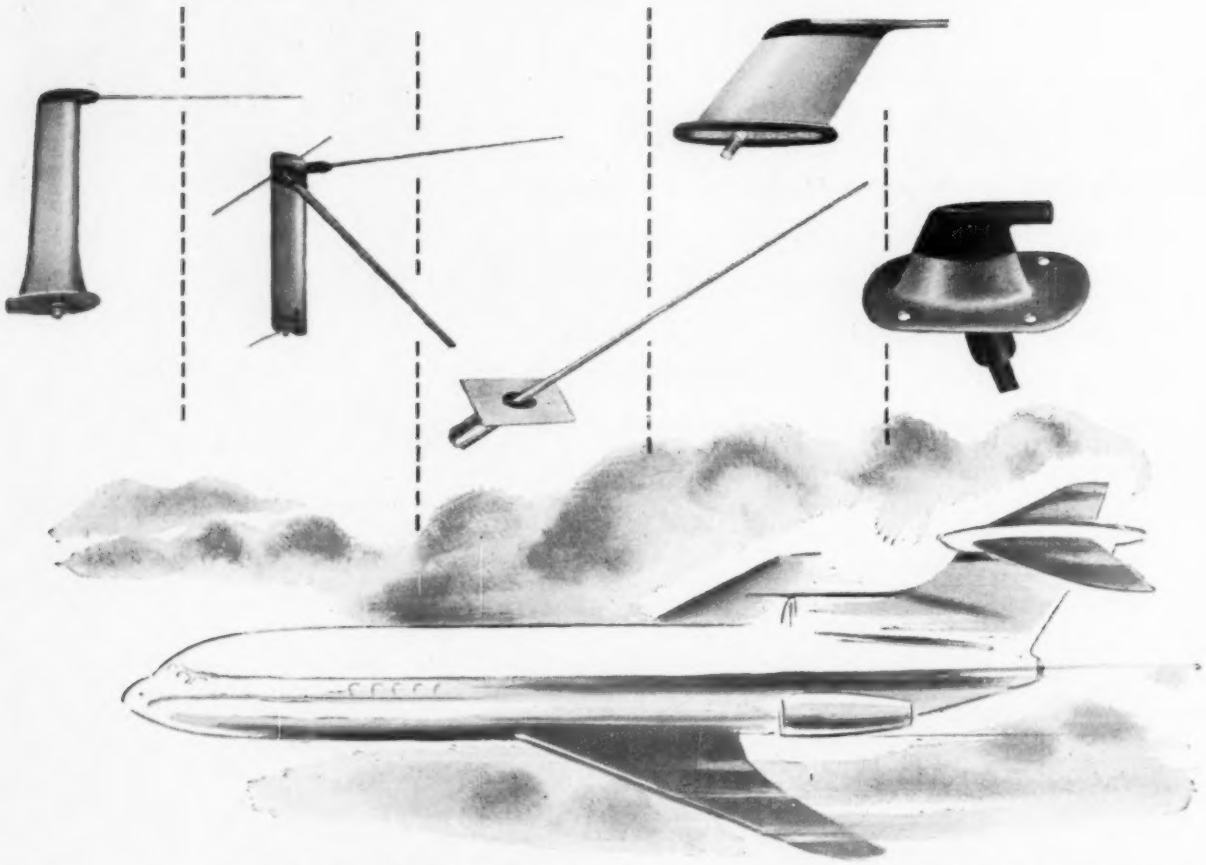

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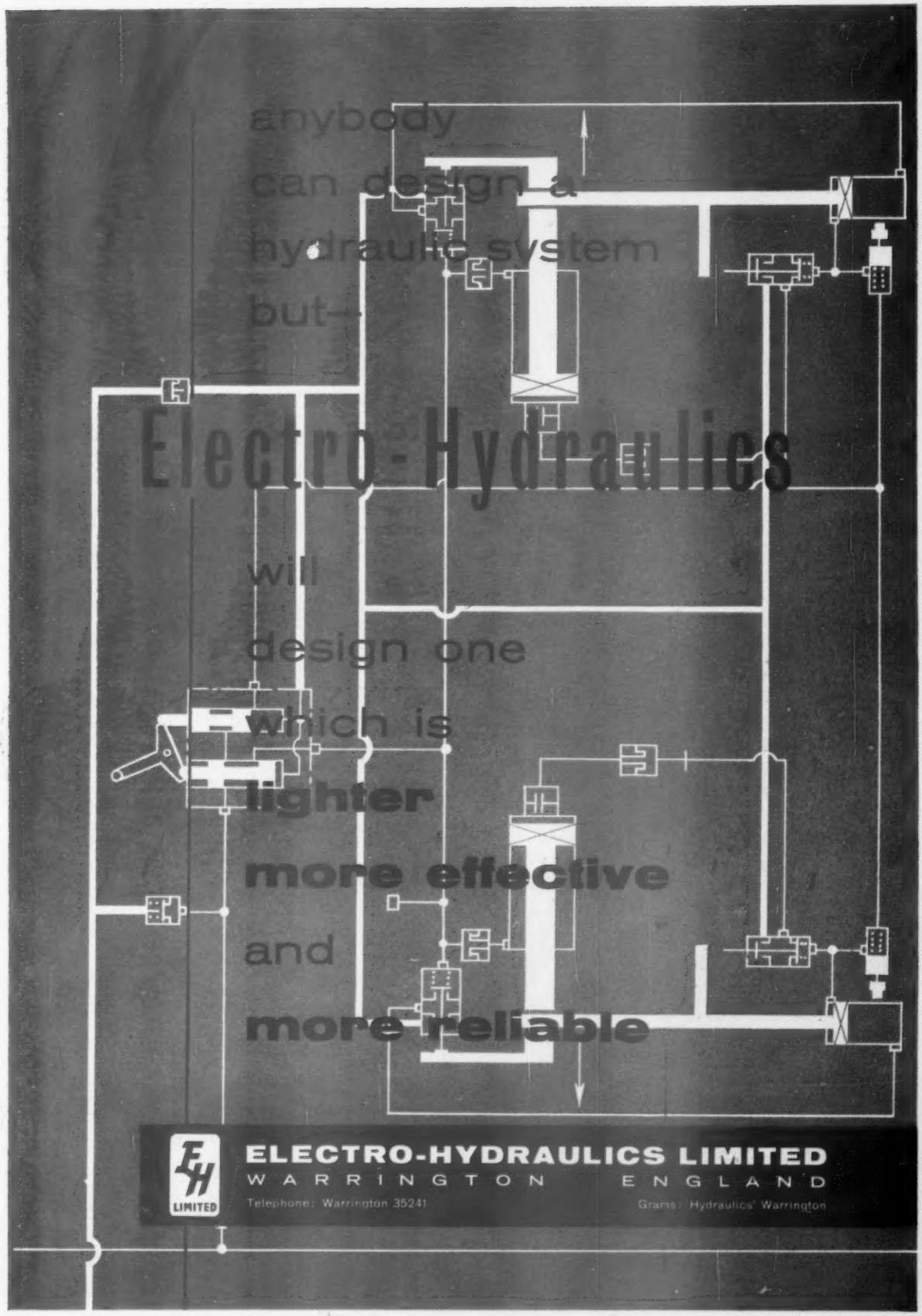
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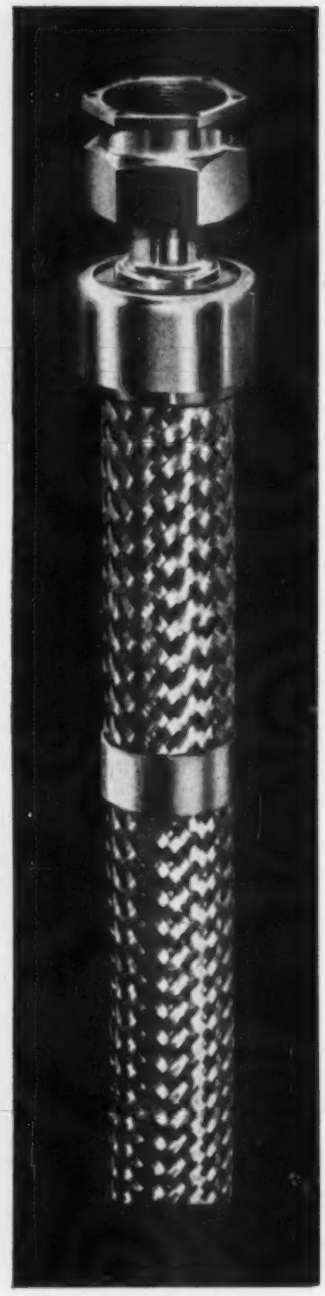

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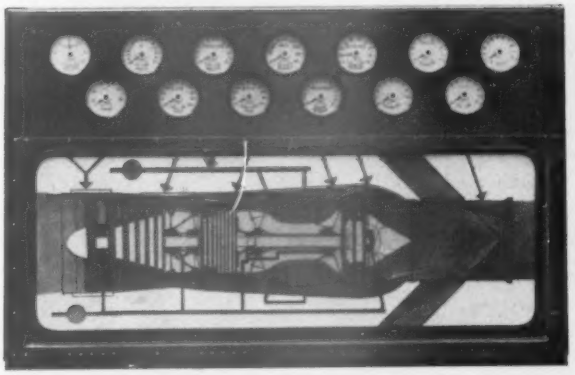

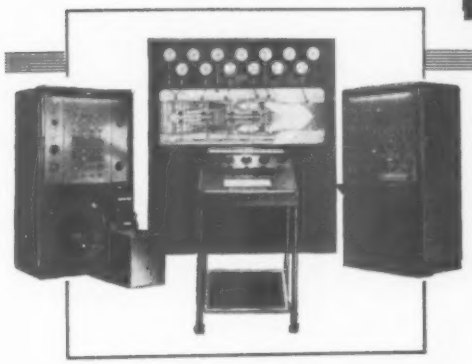

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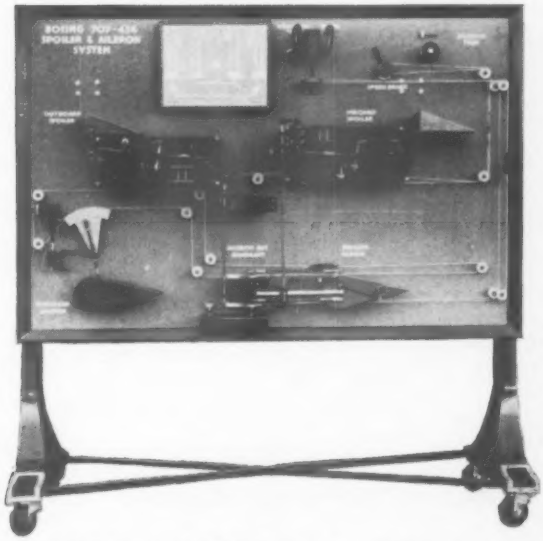

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Beyond our skies

The Moon

The moon is large as a satellite, with a volume one fiftieth that of the earth, and it might almost be called a fifth planet forming a sub-system in the solar system. Research has shown that the moon has little or no atmosphere, for its reflective capacity or 'albedo' is low: it reflects only seven per cent of the sunlight it receives. Hence the absence of blue skies on the moon, but a 'daytime' in which the stars are visible together with a blazing sun in the black firmament.

We have become familiar with "artists' impressions" of the lunar landscape. The surface seems to be composed of porous rock, possibly pumice, and covered in volcanic ash. It has been maintained that remnants of an atmosphere exist in the deeper declivities, and certain surface changes which seem to indicate vegetation would bear this out.

Craggy, dusty, airless—but for mankind distance has lent enchantment to the moon. She has smiled benignly on happy lovers, she has brought mariners home on the tide, she has inspired poetry and music, and to bat, badger and beetle and their like our 'lesser light' is the great queen of the heavens.

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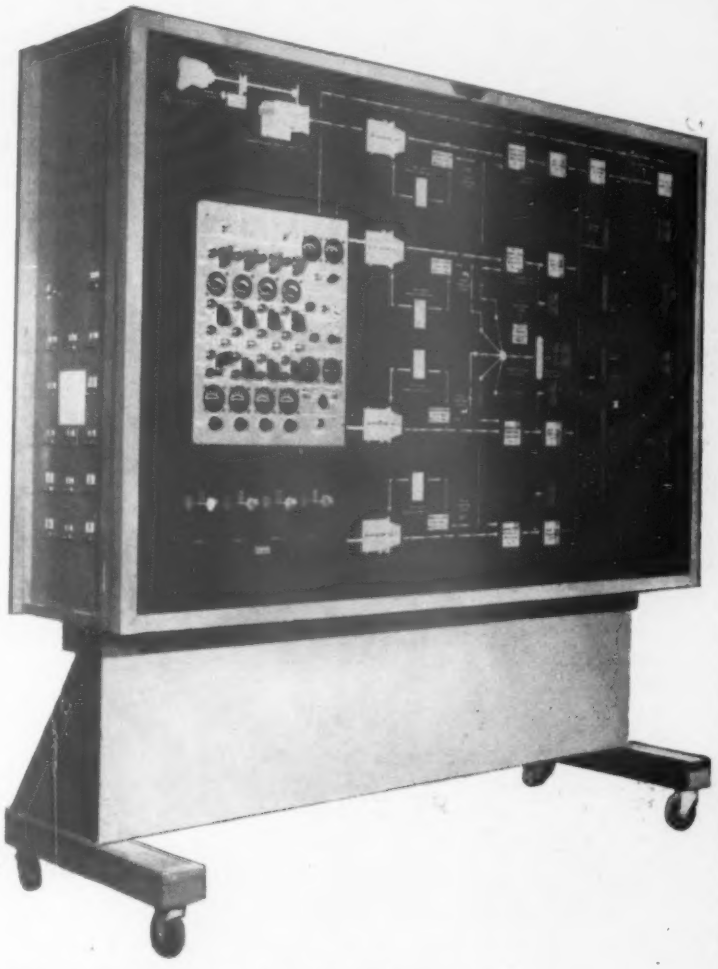

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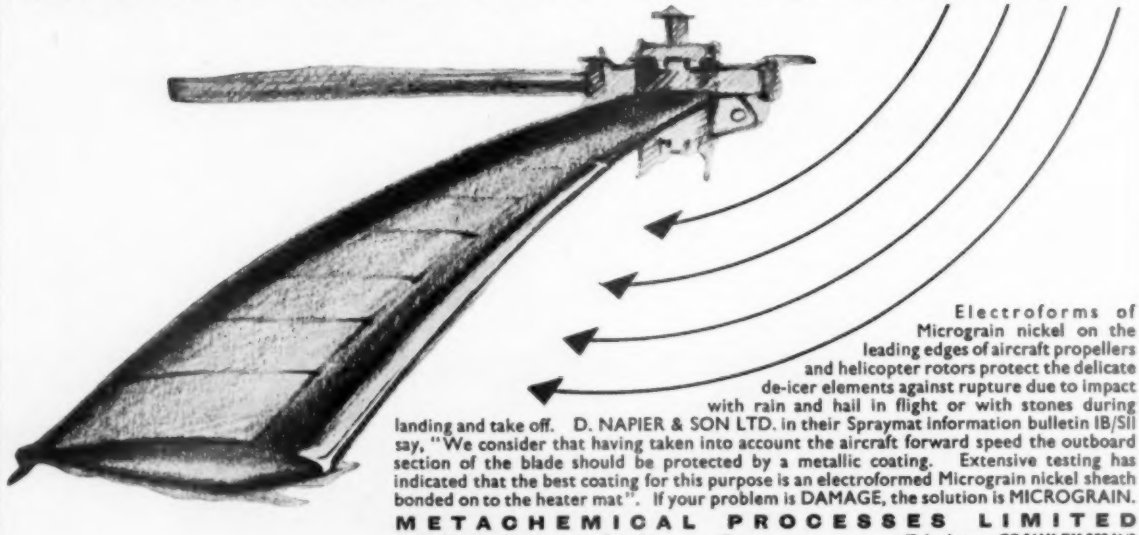

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THE AEROPLANE and ASTRONAUTICS

VOLUME 100 NUMBER 2574 FEBRUARY 17, 1961

Steps to the Stars

Parliament, the mother of them all, our own House of Commons, has recently been told about two new provisions, in the legal or administrative rather than the edible meaning of the word, for the Royal Air Force. These concern disciplinary and recruiting measures.

A day or two later news, which would have been incredible a year or two ago, came that the Russians had launched another heavyweight sputnik and from it have set off towards Venus a space ship which is to be some months on its journey. The news as such did not surprise us and we have been at some pains to provide our readers with articles which should help them understand the problems involved.

Also in the past we have done our uttermost to impress people with the importance of satellites, and of manned satellites in particular, as a means of keeping the peace.

Before these words are read the White Paper on Defence will have been published. Whether it will be as indefinite as forecast by some authorities we do not presume to know. We are prepared to assert definitely, and do, that it will contain no references to any future rôle of the Royal Air Force in space. Yet senior R.A.F. officers have had the courage and vision to point out this rôle.

We reckon that among new provisions for the Royal Air Force should be one that has something to do with interpreting that "A" in a new way. It has been suggested that changing "Air" into "Aero-space" would do the job. The motto certainly reads: "To the Stars."

Tightening the Control

We doubt whether anybody interested in flying around the metropolitan area can truthfully express surprise at the decision now promulgated by the Ministry of Aviation that all aircraft flying within the London Control Zone will have to observe full IFR procedures in all weather conditions. The main requirements are the filing of a flight plan, an ATC clearance, the holding by the pilot of an instrument rating and the equipping of the aircraft with appropriate radio communication and navigation aids. Such a ruling makes possible official control of all aircraft flying in and out of London Airport.

Such a decision, though a long time a-coming, has long been seen to be necessary. However, examination of the appropriate maps shows that the Ministry of Aviation has, in fact, moved nearer to American practice, for the new zone is smaller than its predecessor. It is true that it includes the aerodromes at Denham, Fair Oaks and White Waltham, but to each of them a corridor has been allocated wherein at appropriate heights (never more than 1,500 ft.) non-IFR-qualified aircraft may fly in and out.

Recent accidents in densely populated areas have had such reactions that the public is not likely to do other than welcome the decision.

Operators and users of executive aircraft who, by the nature of their needs will have already qualified to operate aircraft in such conditions, can only welcome anything which makes the use of the air more safe.

Private flyers may feel, as we all do at some time, that every added restriction makes life less worth living or, in this case, flying less fun. The problem then, is to make the private pilots better disposed and this can be done by simplifying the communications channels.

D

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Matters of Moment

Launching Pad in Space

AS readers of this journal will be well aware, the launching of a Russian space-probe to Venus had been expected for some weeks. Last month (Jan. 20) we published Mr. Stuart Greenwood's article, "Probes to Venus," which dealt with the problem in some detail. In it he said:

> "The Soviet Union could now launch at least half a ton towards Venus. It is curious that they have yet to place a probe in orbit inside the Earth's orbit, and this may prove a suitable opportunity for them to do so."

In fact, the mass of the Soviet automatic interplanetary station is about 1,420 lb. However, the Russians did not choose the orbit of minimum-energy (the so-called Hohmann transfer orbit) which would have meant launching in mid-January but delayed their attempt until Feb. 12. The journey time has therefore been contracted from 146 days to about 100 days, and if correctly aimed the probe is expected to cross the orbit of Venus rather than merely graze it.

Announcing the launching, the *Tass* statement said: "In conformity with the Soviet space research programme, a heavy artificial satellite of the Earth was orbited in the Soviet Union today by an improved multi-stage rocket. On the same day, a guided space rocket, launched from the sputnik, set an automatic interplanetary station on a flight to the planet Venus. . . .

"The automatic interplanetary station will reach the vicinity of the planet Venus in the second half of May, 1961. The main object of the probe is to check the methods of injecting a space body into an interplanetary trajectory, to check radio communications over great distances and the guiding of a space station, to check more exactly the size of the solar system and to carry out a programme of physical observations in outer space. The automatic interplanetary station carries a pennant with the coat of arms of the U.S.S.R."

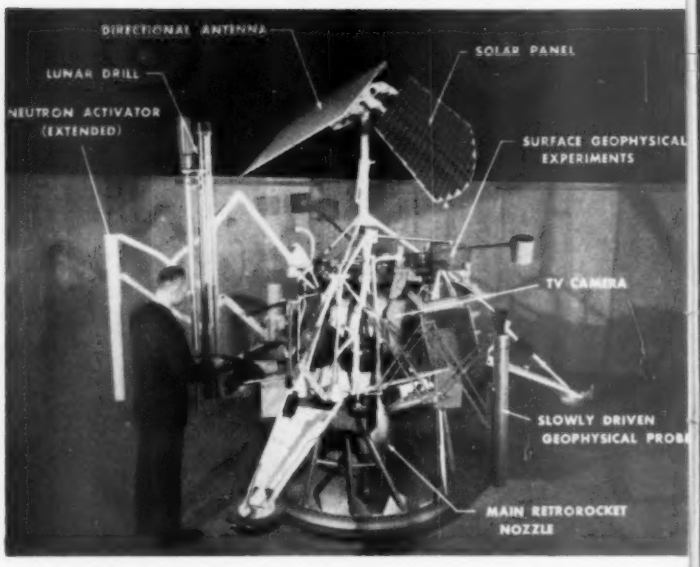
If the probe continues to function normally throughout its 60-million-mile journey it will require the services of elaborate ground tracking facilities, both to bring into effect any command equipment it may embody and receive its telemetered signals. The probe is stated to be transmitting on 922.8 Mc/s.

Russia is not believed to possess a radio-telescope of the size—250 ft. dia.—which exists in Britain at Jodrell Bank. A smaller 72-ft.-diameter directionable radio-telescope with a parabolic reflector, erected in the vicinity of Moscow, is designed to receive radio signals from cosmic sources in the one-centimetre wavelength range. It may well be that as the Venus probe recedes farther from the Earth, the Russians may request Jodrell Bank to participate in the programme. America has an 85-ft.-diameter deep-space tracking facility at Goldstone in California, and two more are being established at Krugersdorp in South Africa and Woomera, Australia, under an agreement with NASA. It was, it will be recalled, Jodrell Bank which communicated with the American solar-probe, Pioneer V, out to a distance of 22.5 million miles last year.

Perhaps the most remarkable feature of the experiment is that the probe should have been launched from orbit rather than directly from the Earth's surface. To achieve this a heavy satellite must first have been placed in a low-altitude waiting orbit. After the orbital parameters had been rigorously calculated on the basis of ground observation, the launching of the probe would have been carried out under remote control by means of a booster rocket housed in the sputnik. Moreover, to achieve the desired accuracy the sputnik itself would be "aimed," which implies that it has three-axis stabilization and a (gas-jet?) orientation control system.

This technique, though unusual in its present application, is not unique. The Agena stage of U.S. Discoverer satellites has this same pointing ability for the purpose of aiming the 300-lb. re-entry capsule down into the Earth's atmosphere at a backward angle of 60°. Midas and Samos satellites are also orientated, but in this case they are kept nose-down with respect to the Earth so that IR-sensors and reconnaissance cameras can be operated. Indeed, it should not be overlooked that the Russian Moon-probe Lunik III—the first "automatic interplanetary station" of 613 lb.—was also orientated about three axes to permit a camera to be trained on the Moon's hidden face. This was done in October, 1959.

It remains to be seen whether the Russians will use their heavy orientable sputnik for other purposes. Apart from the ability to point cameras outward for astronomical observation, Earthward for weather and military reconnaissance, and the return from orbit of re-entry capsules, the same basic system could also be applied for the inspection and destruction of hostile satellites in coincident orbits. This is not to read into the Soviet achievement any sinister motives beyond those of interplanetary research, but clearly the ability to orientate a heavy satellite with accuracy is the key to many applications.



MOON MACHINE.—First picture of the full-scale mock-up of the Surveyor spacecraft which the Hughes Aircraft Company is to develop for NASA's Moon-exploration programme. Among its equipment, described in our article last week, is a rock drill for obtaining samples of the lunar surface.

In terms of interplanetary exploration, we can look forward to further launchings using the same technique. Both Venus and Mars will be favourably placed in 1962, and it may well be that the Moon will receive further attention before then. A soft-landing of instruments must be high on the Russian launching schedule as well as further photographic missions under different conditions of surface illumination.

The sputnik launching technique might also be seen as a small-scale foretaste of the future of manned spaceflight. The launching of an interplanetary spaceship from a space-station orbiting the Earth is one of the classical ideas of astronautics. When the Russians have also demonstrated the ability to refuel rockets in orbit, the principle may be applied to the needs of human exploration of the Moon.

Expenditure on Blue Streak

WHEN development of Blue Streak as a long-range missile was ended in April last year, a Government decision on its use as a satellite launcher was expected within two months. This is stated in the 1959-60 Civil Appropriation Accounts, which survey the financial history of the Blue Streak project.

Following a preliminary study completed in 1955, work on Blue Streak development began. A main contractor was made responsible for overall design and development. Separate contracts were given for development of the motor, fuel and guidance systems. Test and other facilities were to be provided at Ministry of Supply establishments, one of which (Spadeadam) was set up specially for the purpose.

To quote the Civil Appropriation Accounts, "The Ministry tentatively estimated that the whole project would require expenditure of £50 million over a period of 10 years to include extramural development costs, capital facilities, test vehicles and range facilities but not current intramural costs. It was hoped that if all went well the test firing stage would have been reached at the end of this period." [Presumably this should read "concluded" rather than "reached."]

"During the course of the work revised estimates of the total cost of the project were prepared from time to time. In October, 1957 the Treasury were informed that it was then estimated that the total cost of development including the whole test firing programme would amount to between £160 million and £200 million. Early in 1960 the estimate had risen to between £280 million and £310 million. These later figures include additionally an assessed amount for current intramural expenditure which, in the case of the 1960 estimate, amounted to

£48 million. It was later estimated that the cost of production and of the construction of operational launching sites might bring the total cost of the weapon project to something of the order of £500 million-£600 million."

Up to March 31, 1960 a total of about £67 million had been spent on the project. This included about £23 million paid to the four main contractors, £21 million spent on construction and operation of the Spadeadam establishment and a proportion assessed to £9.5 million of the cost of Woomera, which is financed jointly with the Australian Government.

When Blue Streak was cancelled for use as a missile, contractors were told that all work not needed for development of the system as a satellite launcher was to end as soon as possible. One contract was cancelled and a revised programme drawn up for the others. Contractors were authorized to continue work at a reduced rate subject to limits of expenditure which were notified to them monthly.

The Appropriation Accounts do not mention the current rate of expenditure on the project. It has been reported, however, that expenditure is running close to £1 million a month. This approaches the average monthly expenditure which would be involved in a joint European programme based on Blue Streak; this is estimated to cost £70 million over five years.

R.A.F. Provisions of Import

IN moving the second reading of the Army and Air Force Bill in the House of Commons on Feb. 2 the Secretary of State for War, MR. JOHN PROFUMO, outlined two new provisions of considerable import. As to the first, which concerns recruitment, the minimum length of pensionable engagement remains as before at 22 years. But whereas at present a recruit to the R.A.F. can enlist for a term not exceeding 12 years and must serve four years before applying to re-engage to complete the 22, it is now proposed that a man who decides to make the Service his career can contract initially to serve the full pensionable engagement—thus knowing from his first day just how and where he stands. Intelligently publicized, this logical step should go a long way towards encouraging the sought-after serious recruit.

The second provision amends the penal code as laid down in the main Air Force Act to the extent of introducing an additional penalty for use in appropriate circumstances—"forfeiture of a sum from pay." In the case of officers, warrant officers and N.C.O.s this punishment is to rank in ascending order of severity between severe reprimand and forfeiture of seniority, and for aircraftmen between restriction of privileges and detention.

The new provision applies to all ranks, whether on active service or not, and may be awarded summarily or by court martial. In the former case, in common with all sentences entailing directly or indirectly a financial penalty, it confers on the accused an option to elect trial by court martial. (In that connection, one remembers gratefully the much-decorated operational commanding officer—God bless him—who, unused to disciplinary procedure and receiving a whispered reminder from his warrant officer, addressed an airman accused before him thus: "I find you guilty and I must ask you a question. Will you accept my apology, or do you elect that I should undergo a court martial?")

Seriously, though, this addition to the code is overdue and will remove a source of ever-recurring embarrassment to those charged with administering justice and, occasionally, one must admit of overweighted retribution to those who stand to receive it. The new punishment is of course in essence a fine or, more accurately, an attachment of pay (allowances are expressly excluded from forfeiture, thus obviating possible hardship).

Hitherto, with a few exceptions seldom encountered, direct financial penalties have been sanctioned only in cases of drunkenness or to make good damage or loss occasioned wilfully or by negligence. In consequence, not infrequently a commanding officer or a court martial has been faced with the alternative of letting an accused off too lightly or inflicting a sentence too onerous for the offence; for, while reprimands can be (and have been) laughed off and lived down, loss of seniority can (and has been known to) affect an individual throughout his whole service and even curtail it by advancing his retirement date, and detention, apart from its rigour, can leave an almost ineradicable stigma. Here, then, is surely the very sentence for such cases—a short, sharp fine ("and don't do it again!")—to make everybody happy, accuser and accused alike.

A corollary stems from this provision in the case of aircraftmen. A man in detention automatically forfeits pay for the period. Now, by awarding "forfeiture of a sum from pay," it will become possible to dock a man's pay without being deprived of his services. Even though a man concerned might forcibly give one to understand that he couldn't care less about that aspect of the matter, the other subjects of the Queen will stand to gain.—O.W.H.C.

Algerian Interception

LAST week's interception of the Ilyushin Il-18 carrying the Soviet President, Mr. Brezhnev, on a trip to Morocco, by three French Air Force Vautour fighters over the Mediterranean, appeared to be the result of a mutual misunderstanding. The French seemed unaware of the V.I.P. nature of the flight, otherwise the Vautours would probably not have fired warning shots to deflect the Il-18 from a prohibited area, while the Russians apparently ignored flight instructions radioed over international wavelengths.

France's claim to jurisdiction over air space more than 100 km. from the Algerian coast as a combat zone is not generally recognized. There was certainly no intention, as Moscow claimed, of attacking the Il-18, and the French have expressed regret for the incident.

SKYBOLT CARRIER.—This Vulcan B.2—the first to visit America—is, here, at the Douglas Santa Monica plant where it was recently examined by Douglas engineers to ensure "electrical compatibility" between the aircraft and the Skybolt ALBM which it is scheduled to carry, when these missiles become operational.

Matters of Moment . . . .

IFR Enforced

FROM Mar. 1 all aircraft flying within the London Control Zone, or along and across airways, will be required to adhere to full IFR requirements in all weather conditions. The new ruling was expected—and there are certain exceptions—but last week's NOTAM (No. 51-52/1961) will have come as a shock to the private if not to the professional pilot.

The exceptions permit uncontrolled local and entry/exit-corridor flying below certain stipulated heights for the publicly used aerodromes—Denham, White Waltham and Fairoaks—within the present lozenge-shaped London Zone, and within those portions of airways (except the London and Manchester Control Zones) which lie inside the London, Manchester and Scottish Terminal Control Areas.

Otherwise special A.T.C. clearances will be required for all VFR flights in the areas concerned and the aircraft will normally be expected to carry R/T. Gliders are free to cross airways, but *only* in VMC. (The requirements for IFR include the filing of a flight plan, an A.T.C. clearance, the following of IFR procedures, the holding by the pilot of an Instrument Rating, and the equipment of the aircraft with appropriate radio communication and navigation aids.)

Business Aircraft at LAP

FOLLOWING representations against the restrictions on the use of London (Heathrow) Airport by private aircraft, including a total ban on single-engine types and the requirement for written approval 24 hours in advance, the Minister of Aviation has at last arranged for some relaxation of these conditions. They still have some way to go to match the availability of major airports in the U.S. and on the Continent for unscheduled movements, but they represent a further progression towards the attainment of minimum restrictions on executive and private flying.

Prior permission is still required for such movements, although they may be applied for less than 24 hr. in advance and not in writing. Single-engined aircraft are also to be permitted, provided that the runway in use does not entail relatively low flying over the heavily built-up areas of London.

Aircraft using the airport must be suitably equipped and their pilots qualified to fly in accordance with the flight procedures in the London area under IFR. Since the relaxations are stated to have the aim of enabling non-scheduled and executive aircraft to use L.A.P. more freely during off-peak periods, restrictions during times of heavy traffic continue to apply.

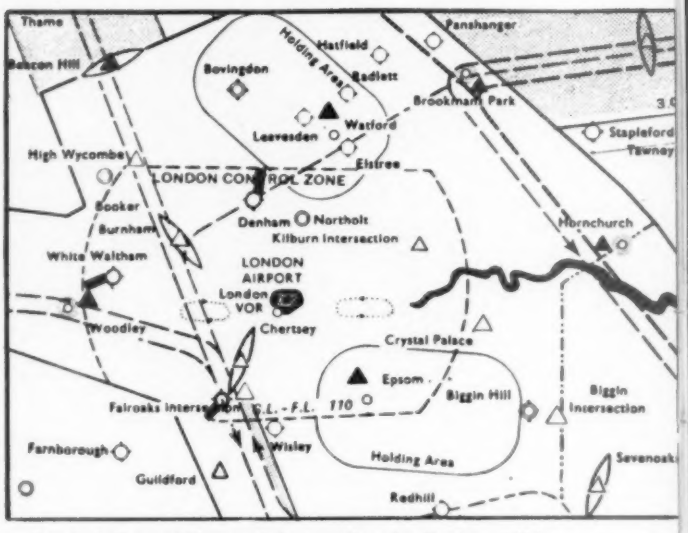
The new regulations are naturally most welcome, and with the revised requirements for permanent IFR procedures in the London Control Zone indicate a substantial move towards rationalization for executive and private operators.

British Helicopter Progress

WESTLAND AIRCRAFT has not yet been able to decide which type of large transport helicopter it should develop. The dilemma facing the company is clearly stated by its chairman, Mr. Eric Mensforth, in his annual report. He says:

> "As a result of the mergers your Group now has three large transport helicopter projects in varying stages of design and development. The Fairey Rotodyne, which utilizes two Rolls-Royce turbines, has been planned as a 60-seater helicopter. It represents a most important new concept, but one on which a great deal of research and development remains to be done. The considerably smaller machine currently flying is an operational prototype.
>
> "Work on the Westland Napier Eland-turbined Westminster has been suspended owing to lack of British military support. We have, however, derived great technical benefit from our prototype operation. Preliminary design work on the Bristol 194, a tandem rotor 40/48-seater helicopter powered by four de Havilland Gnome gas turbines is proceeding.
>
> "The decision as to the project on which to concentrate resources is a vital one for the future of the company. Very detailed discussions on all aspects of this have been taking place with the Ministry of Aviation and civil operators during the past few months, and it is hoped that they will be completed in the very near future. The importance of this decision cannot be overemphasized; although our resources of design, production and finance are very considerable they must be deployed decisively if in the intensely competitive environment of the future we are to be successful. The greatest benefit of the merger of the helicopter industry can only be achieved by concentrating the Group's work on civil and military types saleable in quantity in this country and in the export market."

Progress with other Westland helicopters is also surveyed.



London's Control Zone and the corridors for Denham, White Waltham and Fairoaks.

The Belvedere is in production with the Bristol Division and is due in service in mid-1961. A civil variant, the 192C, is in an advanced stage of design. It will carry 20-25 passengers. The 192C has been offered to B.E.A. for their proposed helicopter service between Lands End and the Scilly Isles.

The development batch of Wessex 1 anti-submarine helicopters has been completed and production deliveries have begun. Development work has begun on the Wessex 2 powered by two Gnome turboshaft engines. Although designed primarily for the R.A.F. and Army, the twin-engined reliability and altitude performance of this helicopter should be of value in territories hitherto unsuitable for helicopters. Further developments of the Wessex 2 are being considered.

Whirlwind production is now concentrated on the Gnome-powered version; substantial orders have been received both for new Gnome-powered helicopters and for re-engining piston-engined Whirlwinds.

The Scout five-seater helicopter is to be produced by the Fairey Division. Both development and production orders have been received for this helicopter, which was developed by the Saunders-Roe Division as the P.531. Production of the five-seater Widgeon will end when a civil version of the Scout becomes available. Design studies are being made for a small helicopter to replace the Skeeter.

Arrangements are being made to increase the firing programme of the Black Knight research rocket over the next two years. It continues in production at the Saunders-Roe Division.

Hovercraft development continues. Experimental work on the S.R.N.1 has given design data for the 27-ton S.R.N.2 which will be on test later this year. It will carry 68 passengers at 70 kts. and is primarily an operational research prototype; its engineering is applicable to craft of up to 300 tons. The S.R.N.2 is a joint venture by Westland and Hovercraft Development, Ltd.

Normalair, a Westland subsidiary, is supplying equipment for the Bristol 188, the Hindustan H.F. 24, the Hispano H.A. 200, the Weser-Nord Transall and the "Heinkel-Messerschmitt VTOL aircraft being built in Germany."

Financial results for the year to Sept. 30, 1960, showed a profit of £2,583,255 compared with £2,088,909 in the previous accounts which covered a 15-month period. From the net profit of £1,330,861 a sum of £500,000 is being put into the general reserve, which has been re-named the general development reserve. This now totals £2,300,000, "which sum may well be needed in future to cover development costs and any other contingencies inherent in the aircraft industry."

The 1961 Defence White Paper

NO revolutionary changes in policy are indicated in the 1961 Defence White Paper, which was published as we went to press. It is in very general terms and refers to far fewer specific projects than did the 1960 White Paper. Hardly any types of missile or aircraft are mentioned by name, and the White Paper as a whole states unexceptionable aims, but is very vague on the means for achieving them. We propose to deal at greater length with its contents and implications next week.

Thruxton's New Lightplane Projects

FROM the Wiltshire School of Flying, Ltd., at Thruxton, comes news of designs for two new light aircraft—a two-seat trainer to be known as the E.S.1 Tutor, and a four-seat tourer, the E.S.2 Paragon. These two projects have been designed with four principal objects in mind:—

(a) To obtain a far longer life of units than achieved hitherto.

(b) To have fewer operations in the maintenance and overhaul schedules, absorbing fewer man-hours per schedule and as far as possible so simple that semi-skilled labour could be used.

(c) To have less frequent intervals between maintenance and overhaul schedules for engine and airframe than is the case with any other type of aircraft.

(d) To have a manufacturing cost not more than three-quarters that required of current types of light aircraft.

Although the two craft appear to be basically utilitarian in layout, it is claimed that they are revolutionary in structural design. This, it is said, makes possible the four objectives listed above, facilitates mass production and prefabrication, and assembly of the aircraft by unskilled labour. The designs have been submitted to the M.o.A. and negotiations are in progress with a manufacturing concern in Canada and another in Switzerland with a view to getting them into large-scale production.

For the fuselage, prefabricated side-girders of either welded-steel tube or sheet metal stampings are connected by cross-struts and wire braced. All these components are the same for both aeroplanes—except that the side girders for the two-seater have a 2-ft. bay cut from them. The wing structure is built up with a number of identical pressed ribs on tubular spars. To all intents and purposes, throughout the airframe there is complete interchangeability of components. In fact, the principal structural difference between these two aircraft is that the two-seater is 2 ft. shorter and has 3 ft. cut off each "standard" wing.

The Tutor trainer is powered by a 140-b.h.p. Lycoming O-290-D2B and has a design weight of 1,700 lb. Its estimated cruising speed is 110 m.p.h. and it is to cost about £2,200.

The Paragon tourer has a 180-b.h.p. Lycoming O-360-A1A and a design weight of 2,500 lb. Its estimated cruising speed is 120 m.p.h. and its cost approximately £2,500.

New Italian Cold-jet Helicopter

FIAT'S new helicopter, the 7002, made its first flight from Caselle airfield near Turin on Jan. 26. The flight lasted 30 minutes.

The Fiat 7002 is in the medium range of helicopters with an empty weight of 1,488 lb. and designed to carry a useful load of 1,598 lb. It has seating capacity for a pilot and six passengers in the civil transport rôle. Many other arrangements are possible to suit employment in military or commercial rôles.

The two-blade rotor, which has a diameter of 12 m (39 ft. 4 in.) is driven by cold jets at the blade tips. The compressed air is provided by a Fiat 4700 turbo-generator in which a hot gas generator operates a turbine-driven air compressor. A small tail rotor, mechanically connected to the main rotor, provides, in the absence of reaction torque, manœuvrability at low forward speeds or in auto-rotation, even if vertical.

The rotor blades have a leading-edge spar made of stainless-steel welded sheet. The trailing edge is of a plastic material with an aluminium honeycomb filling. A welded connector at the blade tip carries the compressed-air jet-nozzle. The rotor hub consists of a main shaft, which carries a tilting unit, through a universal joint, and the rotor hub base, which houses the blade-pitch control shafts and the gears driving the tail rotor. The blades are attached to the tilting unit by means of a flange at the root of the spar and by torsion-tension straps, which bear the centrifugal loads and allow for pitch variation.

The fuselage, of light alloy sheet, is divided into three sections. The front section accommodates the pilot and flying controls; the middle section carries the passengers or other loads; the rear section houses the Fiat 4700 compressed air turbo-generator. Large clear vision panels in the forward and middle sections allow excellent all-round visibility for both pilot and passengers. Fuel tanks are carried above the cabin.

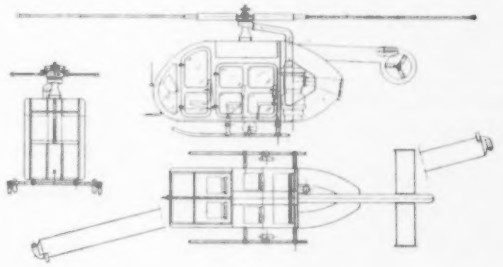
The undercarriage consists of two light alloy tubular skids, which are provided with folding wheels to allow manœuvring on the ground.

Side-by-side seating for two pilots, with dual controls, is provided in the forward section. The port set of controls is removable. Cyclic and collective pitch controls operate through a servo system. Control of the turbo-generator is effected by a twist-grip throttle on the collective pitch lever.

The Fiat 4700 engine is mounted vertically in the rear section of the fuselage. The engine was specifically developed for application to helicopters with the cold-jet system of rotor propulsion. It consists of two independent units. The primary engine comprises a compressor, combustion chamber and axial flow turbine; its function is to generate gas to be fed to a free turbine which drives the air compressor.

Air from the compressor is ducted through the rotor hub to the blade tips. The exhaust gases from the free turbine, which is a single-stage, axial-flow type, are turned through 90° in the exhaust manifold so that they are emitted along the horizontal axis and thus provide a certain amount of forward thrust.

The compressed air generator, made up of the free turbine and air compressor, is a self-contained unit fixed to the primary engine by means of a sheet metal structure. Dismantling and reassembly of the unit is simple because there is no necessity for perfect alignment with the primary turbine. Complete interchangeability of these units is thus assured.—T. D. CALNAN.



FIAT 7002 Helicopter

DIMENSIONS.—Rotor diameter, 39 ft. 4 in.; blade chord, 1 ft. 5 in.; fuselage length, 20 ft. 1 in.; fuselage width, 4 ft. 7 in.; fuselage height, 6 ft. 3 in.; max. height, 9 ft. 9 in.

WEIGHTS.—Normal gross weight, 3,087 lb.; empty weight, 1,488 lb.; useful load, 1,598 lb.

PERFORMANCE (Design).—Max. speed (sea-level, I.S.A.), 106 m.p.h.; cruising speed (sea-level, I.S.A.), 90 m.p.h.; service ceiling in forward flight (max. load), 11,155 ft.; range, 186 miles.

FIAT 4700 Turbo-generator

CHARACTERISTICS.—Height, 51 in.; diameter, 24 in.; weight, 304 lb.; fuel, MIL-F-5624-JP4; take-off power, 542 gas h.p.; shaft power, 671 h.p.; residual thrust, 88 lb.; air mass flow, 7.7 lb./sec.; generator air pressure, 42.7 lb./sq.in.

DEBUT.—The Fiat 7002 being serviced.

Aviation News in General

SHELL CONTRACT.—The Shell International Petroleum Co. is to supply 97% of the aviation fuel requirements of B.O.A.C. and eight associated airlines for three years beginning Apr. 1, with a further two-year option. In the first year, it is expected that 5½ million barrels of fuel will be supplied at 129 airfields in 54 countries, rising to 10 million barrels in the fifth year.

RUSSIAN HOVERCRAFT.—According to the Soviet news agency Tass, an experimental air-cushion-riding vehicle has been designed by a group of Russian engineers. Measuring 55 ft. long and 20 ft. wide the machine is intended to convey 38 passengers at speeds of 25-30 m.p.h. over water. Construction is said to be largely of light alloys and plastics.

MACH-MAN.—Major Robert White of the U.S.A.F. touched 2,112 m.p.h. in an X-15 research aircraft flown from Edwards A.F.B., Calif., on Feb. 8. Flight was described as a "tune-up" for faster and higher testing of the X-15 using the new Reaction Motors XLR-99 rocket engine of over 50,000 lb. s.t.

FLYING DOCTOR. — Northern Nigeria is to have its own flying doctor service as a result of proposals put forward by a Dr. Duncan, a former flying doctor in Australia. The service, which will be based on Gusau, will start in January, 1962, it is hoped.

SKYHAWK THOUSAND. — The 1,000th Douglas Skyhawk built, an A4D-2N, has been delivered to the U.S. Navy. Latest version, the J-52-powered A4D-5, is currently in production at the Douglas El Segundo division.

ARGOSY PROBLEM.—The three Armstrong Whitworth Argosies delivered to Riddle Airlines so far were withdrawn from service early this month for the modification of elevator and flaps following discovery of stress cracks. Modification kits were flown out from the U.K.

TEDDINGTON TUNNEL.—A Mach 7 wind-tunnel for the aerodynamics division of the National Physical Laboratories is to be built at Teddington. The Ministry of Works contract worth more than £50,000 has been given to Hall Engineering, Ltd., of Shrewsbury.

LUFTWAFFE TRAINING. — Sixty-five of the 100 R.A.F. flying instructors seconded to train West German Air Force pilots in August, 1958, are to stay in Germany for a further period of 2½ years. A further 18 are replacing the 35 returning to this country, so that 83 R.A.F. instructors will continue to train Luftwaffe pilots until at least the end of 1963.

NEW FIN.—This recent photograph of the Britten-Norman Cushioncraft "flying" at Bembridge is the first to show it with its new vertical surface.

COMMONWEALTH RADAR.—French high-powered 23-cm. long-range aerodrome radar installations manufactured by C.S.F. have been ordered by the Australian Civil Aviation Board for Adelaide and Sydney, and by the South African Transport Department for Malan Airport, Capetown. The South African contract includes C.S.F. equipment for the distribution of radar presentations by television.

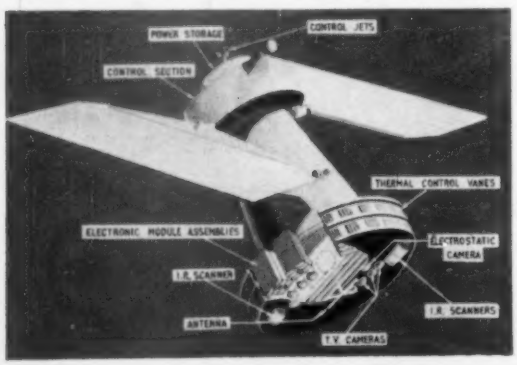
SIKORSKY LICENCE. — Weser Flugzeugbau G.m.b.H., of Bremen, has been granted an option for the licence manufacture of the amphibious Sikorsky S-61D. This type is being offered to the Federal German Republic to meet its need for a large transport helicopter.

BELL FIRST.—The Allison T63 turbo-shaft-powered Bell HUL-1M made its first flight on Jan. 6. It was illustrated in our issue for Jan. 27.

MISSILE RADAR.—The development model of the Zeus acquisition radar, part of the U.S. Army's Nike-Zeus anti-missile missile system, is now installed at White Sands range, New Mexico. It is housed under a 110-ft. diameter spherical radome built by the Goodyear Aircraft Corpn. who are also producing the complete transmitting and receiving antennae structures for the system.

SEGMENTED.—A second flight-weight, conical, segmented solid propellent rocket motor of 15,000 lb. s.t. has been successfully test fired by the United Technology Corp. at Morgan Hill, Calif.

MONKEYNAUT. — The U.S.A.F. is expected to launch a Rhesus monkey into orbit within the re-entry capsule of a Discoverer satellite next month.



WEATHER PROBE.—This NASA picture illustrates principal features of the stabilized Nimbus meteorological satellite (see article on page 184).

TRANSATLANTIC SATELLITES.—Anglo-American collaboration in the field of satellite communications was foreshadowed by Mr. Bevins, Postmaster-General, in the House of Commons on Feb. 8. "It is quite likely," he said, "that we shall be co-operating with the United States agencies during the next 12 months in an experiment which may involve the British Post Office and other British agencies in putting down a ground station on British territory, and assisting perhaps in certain of the equipment which will go into a satellite." This move was exclusively forecast in our article "Go-ahead for Satellite Relays," in our issue of Feb. 3, 1961, p. 123.

NINE OUT OF NINE.—From the ninth consecutive Black Knight launching at Woomera on Feb. 7 a single-stage vehicle reached an altitude of 500 miles. The re-entry nose cone fell some 60 miles downrange. Apart from re-entry testing the Black Knight was carrying Jodrell Bank instrumentation for the measurement of radio noise above the atmosphere and test instrumentation for the U.S./U.K. S-51 satellite.

VIA THE MOON.—A one-way telephone link between Washington and Woomera via the moon was established on Feb. 11. Messages bounced off the moon were received at Woomera approximately two and half seconds after transmission.

SIGNALS END.—Explorer VIII, the 90-lb. ionospheric direct measurement satellite launched from Cape Canaveral on Nov. 3, 1960, has ceased transmitting. Last signal was heard at Quito, Ecuador, on Dec. 27.

MICRO-G.—NASA are negotiating with the United Aircraft Corporation's Research Laboratories for a 12-month study of an ion-rocket. The project involves using realistic thrust, power supply and weight data to determine the possible payloads, trajectories, and engine operating times for various deep space missions. A $100,000 contract is involved.

TIROS FAULT.—NASA announced on Jan. 19 an indefinite suspension of the programming of wide-angle photographs from the meteorological satellite, Tiros II, launched on Nov. 23, 1960. A fault causing "unprogrammed effects in the timing clock operation and the wide-angle camera system," it is believed, could drain the power supply. Programming of remote narrow-angle photographs also has been suspended temporarily pending study of erratic behaviour in that system. Direct read-outs (without tape-storage) of photographs from both cameras and the IR-sensors are unaffected.

Commercial Aviation Affairs

VOR/DME IN EUROPE.—A plan for the provision of more than 550 VOR and DME facilities at 380 locations in the European-Mediterranean area was drawn up by an ICAO regional air navigation meeting in Paris, attended by representatives of 26 States and four international organizations. The plan will be submitted to the Air Navigation Commission for approval

DC-8 RE-ORDER.—Alitalia has increased its order for DC-8s from eight to 10, with delivery of the extra two aircraft scheduled for the spring of 1962. All Alitalia DC-8s are Conway-engined Series 40s, but those not yet delivered will have all the latest modifications including the new wing leading edge and have a 315,000 lb. gross weight. Value of the new order, which increases the total of DC-8s sold to 159, is $13 million with spares.

A.T.L.B. NEWS.—Cunard Eagle Airways has asked the Air Transport Licensing Board to amend its applications for scheduled European services to make the U.K. terminal London Airport and/or London (Gatwick). The latest issue of Civil Aviation Licensing Notices includes an application from Channel Airways for services from Birmingham and/or Southend to Basle, Zurich and Albenga, using Dakota, Viking and, later, DC-4 aircraft.

NOVEMBER TRAFFIC.—The Ministry of Aviation has reported an increase of 11% in the number of air transport movements at U.K. aerodromes and of 29% in the number of passengers handled during November, 1960. Freight traffic increased by 8%. The number of movements at London Airport increased by 21% and the number of passengers by 33%; increases in the London area as a whole were 17% and 30% respectively.

VERTOL RECORD.—During 1960 New York Airways' fleet of Vertol 44s achieved an operational reliability of 98.8% departures within five minutes of schedule, excluding delays and cancellations due to weather. Over 40,000 scheduled flights were made during the year.

C.A.A. CHANGE.—Responsibility for the operation of Central African Airways was transferred from the Rhodesia and Nyasaland territorial governments to the federal government on Feb. 1. Mr. A. E. P. Robinson, chairman of C.A.A., will become High Commissioner for Rhodesia and Nyasaland in London next April and will be succeeded by Mr. R. M. Taylor who is at present chairman of Richard Costain (Africa), Ltd. Mr. H. E. I. Phillips is succeeded on the C.A.A. board by Colonel W. D. Lewis and Mr. H. H. C. Holderness is leaving the board to become chairman of the Air Services Advisory Board.

CARAVELLE FOR AMERICA.—The first Caravelle VI R, the variant designed for United Airlines, flew on Feb. 6 at Toulouse. New features include Avon 532R with reversers, improved cockpit visibility and lift dumpers.

ELIVIE ORDER.—Alitalia's helicopter operating subsidiary, Elivie, is reported to be negotiating for the purchase of six seven-seat Agusta-Bell 102 helicopters for use on the Naples-Capri-Ischia routes.

AMSTERDAM SERVICE.—A combined service frequency of once an hour on the London-Amsterdam route is planned by B.E.A. and K.L.M. this summer. Departures from London will be at five minutes past the hour from 07.05 to 19.05, with two more at 20.35 and 22.05. All flights will be by Viscount, offering over 800 seats a day in each direction.

UNITED ARAB AIRLINES.—The amalgamation of Misrair and Syrian Airways became legally effective on Jan. 1, 1961, under United Arab law. The company announces that it is purchasing three DC-6s in order to develop new routes in the Middle East, Africa and Asia.

GUERNSEY FERRY. — A vehicle, passenger and freight service between Guernsey and Cherbourg will be introduced by Silver City Airways on Mar. 8 and will operate once a week initially. The frequency of the Hurn-Guernsey freight service was increased from once to five times weekly on Feb. 12 and freight rates for many commodities on this service have been reduced to fivepence per kilo.

ICAO MEMBER.—The Republic of Cyprus has become a member of ICAO, being the 84th State to join.

LOCKHEED FINED.—Fines totalling more than £2,000 are reported to have been imposed upon the Lockheed Aircraft Corporation by the F.A.A. in connection with the delivery of 18 Electras in a defective condition. One is said to have been delivered with a vacuum cleaner in the fuel tank, another with screws and a riveting tool in the tank and others with nuts and bolts missing.

A.R.B. NOTICES.—Among the latest issue of notices to Licensed Aircraft Engineers and Civil Aircraft Owners is the first edition of a new title, "No. 60, Air Operators Certificate," giving details of the engineering competence in respect of an operator's arrangements for aircraft maintenance which the A.R.B. will expect before recommending the issue of a certificate. New issues have been made of notices No. 2, 4 and 10.

B.E.A. TERMINAL.—As an alternative to extending the Continental passenger terminal at London (Heathrow) Central, B.E.A. has proposed to the Ministry of Aviation that it should be allowed to build its own separate terminal, and run it without Government control. A working party has been set up to study the request.

NAVIGATORS' SALARIES.—A new senior grade for navigators and salary increases of £20 to £215 have been introduced by an industrial court ruling in a dispute between navigation officers and B.O.A.C. Maximum salary in the new senior grade will be £2,275 compared with a previous maximum of £1,685. The award is effective from July 15, 1959.

COVENTRY TRIALS. — A B.E.A. Viscount made a number of trial approaches and landings at Coventry Civic Aerodrome, Baginton, on Jan. 31 to test its suitability as a diversionary airport for Manchester.

News About People

GOODYEAR FINANCE. — New appointments in the financial division of the Goodyear Tyre and Rubber Co. (Great Britain), Ltd., include those of Mr. I. Thomsen as financial director and secretary, Mr. L. A. Gibbs as executive officer, Mr. D. G. Birch as treasurer and Mr. N. H. Smith as comptroller of the company's accounting.

NAPIER PRIZE WINNERS.—The 16th annual presentation of indentures and awards to Napier apprentices was held on Jan. 31. Principal prizewinners were: Trade Apprentices R. E. H. Hitchinson, E. F. W. Turner, R. A. Bream and B. Murrin (Certificates of Merit); J. G. Watts (Best Trade Apprentice of Any Year); R. E. H. Hitchinson (Foremen's Trophy and Prizes); L. W. Welch (Technician's Trophy and Prizes); C. J. Watkins (Company's Trophy and Prizes).

Mr. C. G. Erlam, whose new appointments are noted on this page.

B.T.R. CHANGES.—Mr. C. G. Erlam has been elected managing director of Microcell, Ltd., and chairman of Palmer Aero Products, Ltd., two subsidiaries of B.T.R. Industries, Ltd. Chairman of Microcell is now Dr. W. D. Scott and Mr. J. J. Molins becomes assistant managing director. New directors of Palmer Aero Products are Mr. P. L. Watson and Mr. J. A. Hemingway.

HUNTING TO IATA. — Mr. Barry Radley, deputy chief test pilot of Hunting Aircraft, Ltd., has retired from test flying and left the company to become assistant to the technical director of IATA in Montreal.

Air Transport

Cargo-rate Breakdown

THE breakdown of the IATA freight-rate conferences, which ended last Friday without agreement on North Atlantic tariffs, had some immediate repercussions. Pan American announced cuts of up to 63%, using a weight-break system, on North Atlantic rates from Apl. 9 (when the present agreements lapse); T.W.A. also proposes to go ahead with new rates; and B.O.A.C. has said that it will consult the Government on new rates which it wishes to introduce. The Corporation says that it proposed at the conferences a lower overall rate for the North Atlantic than any other carrier.

A statement from IATA had explained that carriers had agreed on the necessity for lower rates, but that individual airlines had their own ideas about how the rates should be based. "Some carriers wish to attract new and bulk traffic by offering substantial general rate cuts across the board at progressively higher volume breakpoints. Still others want to achieve this end through the development of new and volume traffic by offering similar reductions within a system of commodity classifications derived from the existing structure of specific commodity rates." The conferences agreed to maintain the present tariff patterns for Europe, the Middle East and Africa.

Although the Association's statement does not say so, it is believed that before the conferences opened there had been some broad agreement about the form and extent of possible rate reductions, but that Seaboard and Western (which is due to take delivery this summer of CL-44s) came up unexpectedly with the bulk shipment reductions which were outlined in our issue of Feb. 10 ("The Air-Freight Business," p. 140). The overall airline opinion seems to have been that such reductions were too drastic in the present state of air-cargo organizational development.

IATA has set up a group to make an interim study of the European rate structure with a view to its simplification and to the introduction of new promotional features for 1962.

Civil-Military Integration

ON February 15, the Federal Aviation Agency assumed responsibility for all military flight service functions within and around the United States. This move is in continuation of "Project Friendship" under which a number of operations common to both military and civil agencies are being transferred to the F.A.A., primarily for economy.

F.A.A. flight service stations will now be responsible for the transmission of all military flight plan messages from point of departure to destination; transmission of in-flight advisories on weather, airport hazards, etc.; communications searches for overdue aircraft; filing of incident reports and alleged violation reports. The relay of air defence alerts and use of DF net control to assist lost aircraft is also an F.A.A. responsibility. Six Military Flight Service Centers with some 500 personnel will be closed, saving the Air Force nearly $2 million annually.

A New Venezuelan Airline

VIAS INTERNACIONALES AEREAS S.A., or Viasa, has been formed as Venezuela's flag airline for operation of major international services. It will take over the international services previously operated by the Government-owned Linea Aeropostal Venezolana (L.A.V.) and the privately owned Aerovias Venezolanas (Avensa). We understand that both Government and private interests are represented in Viasa, but it is not clear whether these interests include Pan American, which has a 30% share in Avensa. At present, L.A.V. and Avensa are continuing to operate local and regional services, but Viasa has taken over six Super Constellations from the former and two DC-6Bs from the latter.

An agreement has been concluded between Viasa and K.L.M. for the Dutch airline to provide technical, operational and commercial assistance, and to act as Viasa's general agent in Europe. This agreement takes effect on Apr. 1 and on, or shortly after, that date a K.L.M. DC-8 and crew will be chartered to fly services on the routes Caracas-Paris-London-Amsterdam, Caracas-Lisbon-Madrid-Rome, and Caracas-Lima.

Viasa is reported to be ordering three jet transports, one of which may be the Convair 880 which had been ordered by Avensa.

More Boeing 707s

ORDERS for seven more Boeing 707s were in the news last week. Six of the new aircraft, including three which B.O.A.C. is seeking Government permission to buy, will have Rolls-Royce Conway engines. In addition to those for B.O.A.C., the new orders are from Ghana Airways for two and from El Al for one, increasing the total El Al order to three. It is also reported from Australia that Qantas has ordered a fourth turbofan-powered 707-138B, which will be leased from Boeing.

The B.O.A.C. order will not affect the existing VC10 contracts but is made necessary by expanding traffic demands—a 30% increase in capacity is budgeted by the Corporation for the 1961-62 year. It is interesting to recall that B.O.A.C. in 1956 requested permission to buy 17 Boeing 707s but this order was scaled down to 15 by the Treasury. The original B.O.A.C. traffic forecasts have now been vindicated.

Ghana's order is also additional to the recently announced contract for three VC10s. Delivery is to be made in July and August, 1962, and the aircraft are for use on the Accra-London route flown at present by two Britannias. The third 707 for El Al is to be delivered early in 1962 and will increase capacity on the route between Tel Aviv and New York.

BALPA and Capt. Thain

THE British Air Line Pilots Association continues to press for the case of Capt. James Thain to be re-opened. There is now very little doubt—following the report of the Reviewing Body (the "Fay Report") last October and the more recent issue of a Ministry Information Circular—that the cause of the Munich accident on Feb. 6, 1958, was slush on the runway rather than ice on the wings of the Elizabethan, but Capt. Thain was dismissed from B.E.A. because he did not (to use the words of the Fay Report) take sufficient steps to satisfy himself that the wings were free of ice and snow and because, though in command, he was sitting in the second pilot's seat.

Last week-end BALPA described the dismissal as a "gross miscarriage of justice" and suggests that it was "unbelievable" that two experienced captains (Capt. Rayment, who died in the accident, and Capt. Thain), would have ignored reasonable precautions. Capt. Thain's licence had expired when he left B.E.A.'s service and he was therefore prevented from obtaining employment with another operator.

Everyone, inside and outside BALPA, will feel sympathy for Capt. Thain, who has been the victim of a succession of unfortunate circumstances, but the B.E.A. point of view can also be well understood.

ORIENTAL VISITOR.—Japan Air Lines' first over-the-pole proving flight from Tokyo arrived in London on Feb. 11. Regular service on the Tokyo—Anchorage—Copenhagen—London—Paris route will begin on June 1. The J.A.L. fleet of five DC-8s is to be increased to six next year, and two more Convair 880-22Ms are to be ordered this year to provide a total of five for the southeast Asian network.

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Helicopter Prospects

BRITISH EUROPEAN AIRWAYS' plans to resume scheduled helicopter operations, which were discontinued in November, 1956, now depend upon the Government making up its mind about the development of a large passenger-carrying helicopter in this country. The B.E.A. position was made clear by Lord Douglas on the occasion of a Press conference last August and, as it has not changed materially since then, may be worth summarizing again.

The crux of the matter is the acceptability or otherwise of the Westland Rotodyne's noise level for city-centre operations. B.E.A. has asked the Ministry of Aviation, according to Lord Douglas, for a statement that the level of noise expected with the Tyne-engined Rotodyne will be acceptable, or alternatively for an agreement that the military would take the aircraft off the Corporation's hands if city-centre operations proved, in practice, to be impossible.

B.E.A. had written a "letter of intent" for six Rotodynes early in 1959, since when the work of finalizing the specification has gone on, and a year ago the Ministry agreed to contribute £1,400,000 to B.E.A.'s costs of introducing the Rotodyne into service. It is clear, however, that the Corporation intends to go no further in this particular connection until the Ministry's position is clarified.

At least a year ago, too, B.E.A. requested financial assistance from the Government in opening up an interim scheduled helicopter service (on some such route as Land's End-Scillies) to gain experience of multi-engine all-weather operations. By purchasing two or three helicopters of the Westland 192C, Vertol 107-II, or Sikorsky S.61 type, B.E.A. hoped to be able to start this operation in 1961, or 1962 at the latest. The Ministry's position on this request, we understand, was that purchase of British equipment would be a prerequisite for obtaining the subsidy.

B.E.A. now takes the view that it would be unwise to undertake the interim operation unless the long-term plans are assured—by the Ministry either giving the required guarantees for the Rotodyne, or else encouraging the development of the Westland Bristol 194. Detailed discussion of these possibilities have been going on during the past few months, between the Ministry, Westland, B.E.A. and other operators. The chairman of Westland Aircraft, Ltd., in his annual statement made last month, stressed that the decision as to the project on which the company was to concentrate its resources was a vital one for the future, and its importance could not be overemphasized. Of the 60-seat Tyne-engined Rotodyne, Mr. Mensforth said "a great deal of research and development work remains to be done"; of the 40/48-seat, four-Gnome Bristol 194 he said "preliminary design work is proceeding."

It now seems certain that B.E.A. will purchase the interim Bristol 192C if it goes ahead with its helicopter plans at all. This is a version of the Belvedere, in production for the R.A.F., powered by two Napier Gazelles and with a slightly larger fuselage, seating up to 23 passengers. One possible layout is illustrated on this page, in a mock-up at the Bristol Helicopter Division at Weston-super-Mare.

The Air-freight Business

IN London last week Mr. S. C. Dunlap, T.W.A.'s vice-president, cargo sales and market development (and, incidentally, co-founder of the all-freight Slick Airways in 1946), made it clear that most of the big carriers are in favour of overall cargo-rate reductions—but in steady downward steps.

The ton-mile capacity of present equipment may justify useful rate reductions and fairly big consequent increases in freight traffic—but the ability to handle this increased traffic depends on total organization. This organization is not yet ready to deal with the increased traffic volumes which might result from too big and too well-publicized a drop in rates. Experience in the past among U.S. all-freight carriers has shown that a spectacular lowering of tariffs could produce an uncontrollable (and unacceptable) avalanche of offered freight.

This somewhat cautious approach may not produce the expected overnight cargo breakthrough, but there is something to be said for it while the carriers are still uncertain of their ability to offer the extensive ground organization which is essential if a breakthrough is not to have within it the seeds of chaos. Air-freight development is not a matter simply of offering aircraft ton-mile capacity, even if this is backed by the most up-to-date of terminal facilities.

Meanwhile, notwithstanding the temporary value of special commodity rates, there is justification for the view that IATA (if its airlines really want to increase cargo business) should simplify the rate structure. Customers who are thinking of using air transport must often be appalled by the present diversity of tariffs, and must spend an unreasonable amount of time in studying general and specific commodity and proportional rates. The president of Air Express International said last year that the structure around which the present air-freight rates are built is "unrealistic, unscientifically established" and "literally a compounded creature of a haphazard beginning." More recently he has said that he hoped the IATA conferences in Paris would recognize "at long last" the necessity of revising the entire North Atlantic rate structure.

Photograph copyright "The Aeroplane and Astronautics"

CIVIL LAYOUT—This picture shows one of the interior layouts which have been studied in the Bristol 192C mock-up mentioned on this page.

A B.O.A.C.-New Zealand Pool?

SIR MATTHEW SLATTERY, chairman of B.O.A.C., spoke of the possibility of a B.O.A.C. service to New Zealand and a pool arrangement with TEAL, during his recent visit to New Zealand. Although this is still in the stage of long-term planning, we understand that the New Zealand service would be an extension of that to Los Angeles which is to begin on Mar. 2, and that it might continue from New Zealand through Australia to Singapore, where it would link with the Eastern route services. Traffic rights have not yet been requested by B.O.A.C. and it is unlikely that the Corporation would have sufficient capacity for such a service until delivery of the VC10s in 1964.

If a service to New Zealand were opened in partnership with TEAL, the latter might lease aircraft from B.O.A.C. The idea of a Commonwealth airline pool was suggested by Sir Matthew, who said this would allow standardization of equipment and sharing of spare aircraft according to seasonal demands.

The Responsibilities of A.T.C.

DURING the final session of the public investigation into the New York collision, a representative of United Air Lines (whose DC-8 appears to have overshot its holding pattern) read a statement which included the charge "that this accident would not have happened had air traffic control properly utilized the equipment, personnel and facilities available."

Not unnaturally, the Federal Aviation Agency has replied to this charge (and implicit premature blame) in a letter to the chairman of the board of inquiry and this letter has been made public. The points made by the F.A.A. are important in their overall implications.

The letter stresses, first of all, the facts that A.T.C. is a co-operative system which requires, for its success, compliance, by its users, with the procedures laid down, and that a pilot in command is responsible for the navigation of his aircraft. The A.T.C. system provides, in effect, the "stop" and "go" signs and the rules for their use, but cannot physically prevent a user from disregarding them. The rules clearly state, for instance, that when a clearance has been obtained the pilot

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shall not deviate from its provisions until an amended clearance has been obtained. United's DC-8 was given the Preston intersection as a clearance limit and this instruction had been clearly understood.

It was probable that one of the DC-8's VOR receivers was inoperable, but another VOR receiver and two ADFS were available. Extensive ground and flight checks had established that the ground radio aids were functioning properly at the time. No report of malfunction had been received from any of the 4,000 jet aircraft which had used the Preston intersection during the preceding 90 days and another aircraft had, in fact, been using the suspect VOR station (Colt's Neck) both before and after the collision. Had the captain of the DC-8 reported navigation difficulties he would have been given special attention by A.T.C.

The F.A.A. letter outlined improvements in the system which would be made as soon as possible as a result of the facts which the investigation had brought to light. These include a mandatory requirement for distance-measuring equipment in all civil jet aircraft (see our issue of Jan. 13, p. 33). The Agency points out that DME ground equipment had been available at Idlewild for two years and that there were 343 other DME stations in the U.S.A. Yet only two of United's fleet had been equipped. A speed limit for turbojets in terminal areas would also be imposed.

Commuting by VTOL

A FLEET of 360 VTOL 110-seat aircraft, cruising at 600 m.p.h., would allow 60,000 passengers an hour to commute between London and the South Coast towns, according to estimates by Air Chief Marshal Sir Ralph Cochrane, of Rolls-Royce, Ltd. This intriguing suggestion was made in the course of Sir Ralph's paper "Aviation—The Next Stage?" delivered in London last week.*

This operation would be based on having a total of 400 landing pads each occupying, with attendant passenger facilities, an acre of land; 200 would be in London south of the Thames—perhaps on or over railway property—and the other 200 inland from the coastal towns, with adequate car parks. To obtain full advantage of VTOL aircraft, a landing pad should always be available for each aircraft airborne. Assuming minimum and maximum commuting distances of 60 and 120 miles, the block times would be in the region of seven minutes and 14 minutes, so there would probably be a centrally controlled signalling system which would govern the time of take-off in relation to other traffic, and the availability of a pad at the destination.

After take-off, the aircraft would be guided automatically straight on to this pad, i.e., in this type of traffic control decisions would normally take place with the aircraft on the ground, so that once it was released it would be certain of a clear flight along its pre-determined route to its destination. In these circumstances, it seemed reasonable to allow for 10% reserve pads in the system, so that 360 aircraft could operate from 400 pads. If passengers embarked and alighted with the same speed that they are accustomed to in suburban trains, and assuming multi-doors and pressure refuelling, turn-round time might be five minutes or, allowing for an average of two minutes wait for traffic control clearance, a total of seven minutes.

If the average commuting distance were 90 miles and allowing a rate of acceleration and deceleration of $\frac{1}{4}g$. at the beginning and end of the flight, the block speed would be some 500 m.p.h. with a journey time of 11 minutes. If one assumes a load factor throughout the peak travel period of 90%, this gives an hourly capacity of 60,000 passengers. It should be noted how sensitive the calculation is to the turn-round time, and the economics of the operation would largely depend upon reducing this to the absolute minimum.

On the basis of this calculation, the VTOL commuting system provided 300 passengers per acre of land per hour at peak loading, compared with British Railways (Southern Region) figure of 150 and London Airport's 1.8.

Sir Ralph indicated in his paper that commuting and air freighting were the two major classes of traffic where air transport had so far made little impression. In the case of commuting the problem was not so much one of cost as of time and the capacity of the airport to handle rush-hour traffic; this seemed to demand an aeroplane which did not require runways. While freight was held back at present by high costs, its growth might eventually be limited by the availability of runways and the capacity of air traffic control.

It was too early, Sir Ralph thought, to say which method of achieving VTOL would ultimately prove best, but it would be surprising if it looked like a conventional aircraft. Apart from the question of noise, it had to be designed with a low structure weight to offset the weight of the extra power, while still retaining the top speed and economy of a normal aircraft. That ruled out the helicopter, which, while reasonably quiet, had neither the payload nor the speed necessary for really cheap fares.

What was needed was a vehicle with a high subsonic speed, if possible less noisy even than the helicopter, and with the payload of orthodox runway aircraft. Some penalty was to be expected from the suppression of noise, but the author was convinced that this problem would be solved. On the credit side a number of components were no longer needed and this helped to offset the weight of the extra power—for instance, the undercarriage, flaps and other slow-landing devices and thrust reversers would be unnecessary and control surfaces could be smaller.

Of great importance was the ability to design a VTOL type with a wing loading and planform to suit the cruise requirements, without compromise for take-off and landing; high wing loadings would probably be adopted to minimize the effects of turbulence. Fuel reserves would be reduced, because of the constant availability of landing pads already noted above, and because reserve pads could be located along the route and a forced landing in open country would not be catastrophic.

In addition to direct savings in weight and fuel, there are two indirect advantages of VTOL operations. In the first place, all taxi-ing time is eliminated; with fixed-wing aircraft, this averages 16 minutes for a take-off and landing, or some 25% of a typical U.K. domestic flight, yet this time is included in revenue-hour calculations. The second advantage is that VTOL aircraft can land at or near the places where the traffic originates.

Landing pads for VTOL aircraft will need to incorporate some simple form of shock-absorber, replacing that on the aircraft, and a terminal guidance system consisting of small unattended radar beacons for each pad or group of pads. Means of dealing with the large volume of air displaced downwards by the aircraft when taking off and alighting must also be found. Taken together, these requirements were not expected to call for higher landing fees than at present charged for runway aircraft.

New Materials

The importance of structure weight in the economics of all types of aircraft is already recognized, but in the case of VTOL types it has even greater significance. Sir Ralph devoted a considerable portion of his paper to discussing the possibilities of radically new materials which might save 40% of the present structure weight of aircraft and engines to give a 16% reduction in gross weight required for a given payload.

Silica and other fibres had a breaking stress of around 500 tons/sq. in. and an engineering material might be developed to exploit these remarkable strengths. The surfaces of the fibres had to be protected against damage to obtain elasticity and great tensile strength; this was done, for instance, in plastics-reinforced glass-fibre material, but the ageing characteristics of the plastics were not good. Another possible line of development was to use metals not to carry the main loads, but as a glue to distribute them among the high-strength fibres. Low density materials could also be constructed from fibres, not necessarily of very high strength, to achieve either very high rigidity for a given weight, or a considerable weight saving for a given rigidity.

In his concluding remarks, Sir Ralph suggested that the further development of aviation might be made the aim of Britain in collaboration with Western Europe, while the U.S. and Russia vied with each other in all the latest fields of science and technology, including space research. The total population of Western Europe was of the right order of magnitude to support the kind of major research and development programme which was needed, and contained the highest levels of technical and scientific skill in the World. The extension of research, development and production planning beyond the shores of Britain, whether by Government action or private enterprise, was our only real hope of covering the costs of these new projects.

* "Aviation—The Next Stage," the 18th Brancker Memorial Lecture before the Institute of Transport, on Feb. 13.

Global Navigation

AT Farnborough the Radio Department of the R.A.E. is studying the possible development of a World-wide long-range VLF radio navigation system. Depending on the use of an extremely long and stable wavelength which has the capability of global propagation, such a system could provide complete navigational coverage with only six ground stations.

If four of these stations were equally spaced around the equator and one located at each of the poles, or any other arrangement which preserves this relative spacing, an aircraft anywhere on the globe would be within 6,000 n. miles of at least three transmitters. A possible group could be established with the existing VLF transmitting stations at Rugby, Balboa in the Panama Canal Zone, and Hawaii, and new stations sited in Singapore, New Zealand and South Africa.

The operating principle requires an airborne high-stability oscillator working at the same frequency as a ground transmitter, so that, if the aircraft which is carrying it flies from overhead the transmitter in a straight line, the phase of the transmitter slips back with respect to the airborne oscillator because of the time taken for the transmitted signal to reach the aircraft.

With the use of a twin-channel receiver, in which the phase of the signal from the ground transmitter is compared with that of the airborne oscillator, it is possible to measure the number, and fractions, of wavelengths through which the aircraft has flown. For example, the communications transmitter at Rugby operates on a frequency of 16 kc/s, which has a wavelength of very nearly 10 n. miles as it passes over the surface of the Earth, so that an aircraft travelling at 600 knots would go through one wavelength in one minute. The U.S. transmitter at Balboa in the Panama Canal Zone operates on 18 kc/s, which gives a wavelength of approximately 9 n. miles.

In May of last year the Radio Department started VLF radio propagation flight trials with the aid of the Rugby transmitter. Using the Establishment's Comet 2E, local and medium-range flights to and from Malta were made to confirm the airborne stability of the oscillators; to compare phase changes in distance with time and constancy of wavelength with distance from transmitter; and to confirm signal streneth through possible interference areas. Stability checks were made by taking two oscillators and comparing their relative phases in flight, and phase changes were found to be internally consistent to within 1 n. mile. Altogether, these trials involved about 100 hr. flying.

A second series of flight trials started last October, using the transmitters both at Rugby and at Balboa. These trials were made so as to obtain actual position plots by the installation of a second twin-channel receiver in the Comet, so that one worked on Rugby and the other on Balboa. Going as far east as Cyprus and south to Kenya, they proved the practicability of plotting in tropical zones.

Aircraft Position Information

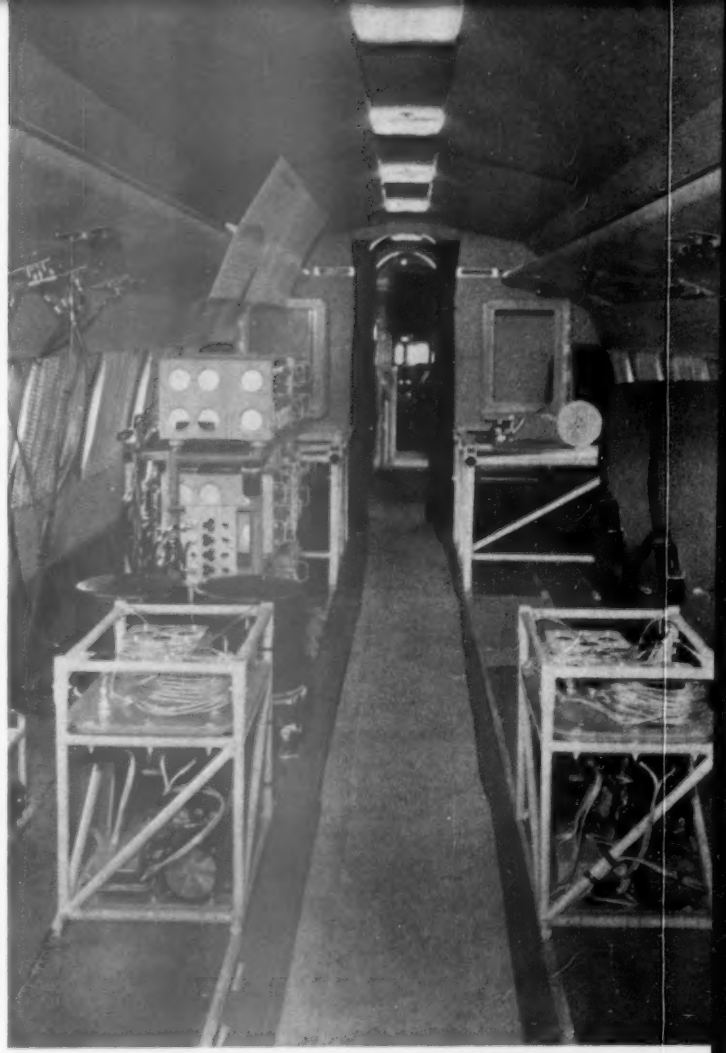
By comparison with Decca or Gee, which use three ground transmitters, the VLF system employs two on the ground with the third represented by the high-stability oscillator in the aircraft. With the latter system fixes are no longer made on a hyperbolic lattice, but on families of circles centred on the two transmitters.

For the purpose of using the transmissions from Rugby and Balboa, standard 1 : 1,000,0000 scale plotting charts were marked with a grid formed of circles centred on the transmitters and with radii equal to integral numbers of wavelengths. A computer programme has been prepared which will provide the data for these families of circles given the latitude and longitude of the transmitters and their operating wavelengths.

Altogether, approximately 25 hr. flying, with manual plotting of aircraft's position using circle grids, has been completed and the next stage, which is planned to start this summer, will be the introduction of an experimental automatic display of this position information. This equipment will plot with a standard pen-trace on a rectangular projection of the circular grid.

Future plans include the development of more advanced displays, presenting the aircraft's position in latitude and longitude, or Northings and Eastings, on standard charts, and more flying experience in the tropics and the Arctic.

For the possible global system described in the first two paragraphs, the airborne equipment might comprise a high-stability oscillator, three twin-channel receivers and a computer for converting phase changes relative to the three ground stations into positional or flight-plan correction information for the pilot. A memory device would also need to be incorporated, so as to overcome possible short breaks in ground transmissions, although the complete system should be able to function on any two of the three stations selected. A day/night control, similar to the Doppler land/sea switch, might also be used to overcome diurnal variations in range measurement.



The interior of the Comet 2E which has been extensively modified, mainly by additions to its power supply systems and the installation of up to six "table tops," to form a flying laboratory for the R.A.E. Radio Department. It is seen here fitted out for VLF radio propagation flight trials in connection with the Department's study into the possible development of a new World-wide navigation system.

Very low frequency waves obtain World-wide propagation from their repeated reflection from the bottom layer of the ionosphere. This changes in height from 250,000 ft. by day to 300,000 ft. by night. As a result, the path between transmitter and receiver is slightly shorter by day than by night, and the day-time wavelength is effectively longer, causing measured distances to appear that much shorter. For example, a day-time flight from Rugby to Malta, approximately 1,200 n. miles, has been found to record a measured distance 3 n.m. less than that undertaken at night.

These diurnal variations of distance have also been the subject of a special study using ground monitor stations at Farnborough, Rome and Malta. From the observations made to date, it would appear that these variations would be estimated to within 2 or 3 n. miles over distances up to 6,000 miles. This sort of correction has already been applied successfully in experimental flights over the Mediterranean using the Balboa transmitter—some 6,100 n. miles from Malta.

The normal pattern of diurnal variation can be disturbed by magnetic storms, but as yet there is not sufficient data to assess these effects, although it is known that they tend to reduce rather than increase the diurnal variation.—P.R.R.

The Fighting Services

R.A.F. Flying College News

GROUP CAPTAIN D. G. SMALLWOOD, D.S.O., M.B.E., D.F.C., A.D.C., is to become A.O.C. and Commandant of the R.A.F. Flying College, Manby, later this month, with the acting rank of Air Commodore.

Flying with No. 605 (County of Warwick) Squadron in the early stages of the War, he was later given command of No. 87 Squadron which he led on two raids on Dieppe in the face of strong opposition from ground defences. He commanded No. 33 Squadron in 1948 and, after a number of staff appointments, became Commanding Officer of R.A.F. Biggin Hill in 1953. He relinquishes command of R.A.F. North Coates to take up his new appointment.

Calshot to Close

THE former R.A.F. seaplane base at Calshot on Southampton Water, which has been a maintenance unit responsible for all major marine craft repair since 1953, is to close next Tuesday, Feb. 21.

Officially opened as a naval air station in March, 1913, the original base consisted of three sheds accommodating 12 seaplanes and at the outbreak of the 1914-18 War it became involved in the defence of the English Channel and the training of naval aircrew. Calshot later became the control centre for the Portsmouth Group of sub-stations and on the formation of the R.A.F. in 1918 this was renamed No. 10 Group. Four months later the three flights at the base were combined to form No. 240 Squadron.

After the War the station became the School of Naval Co-operation and Aerial Navigation, and in 1922 the base of No. 480 Coastal Reconnaissance Flight. Equipped with Felixstowe F. and Supermarine Southampton flying-boats, the flight was renumbered No. 201 Squadron in January, 1929.

The year 1927 saw the first visit from the R.A.F. High Speed Flight, training for the Schneider Trophy race in Venice, which they won. In September, 1929, Calshot was the venue for the R.A.F.'s defence of the Trophy, and again Britain won. Total victory followed two years later when Flt. Lt. J. Boothman had a "fly-over" win to secure the Trophy permanently for Great Britain. The same month saw Flt. Lt. G. Stainforth set up a new World speed record of 407.5 m.p.h.

Training continued at Calshot under the auspices of the Seaplane Training Squadron but, as War approached, all aircraft were moved to operational stations in the north, leaving the base as a general flying-boat and marine craft maintenance station. Nos. 230 and 201 Squadrons returned to Calshot after the War, equipped with Sunderlands, and an officers' training unit for flying-boat pupils was restarted.

In 1948 all Sunderlands were pressed into service for the Berlin airlift. Afterwards the two squadrons returned briefly to Calshot, leaving finally in 1949.

Congo Airlift

SINCE July, 1960, when the Ghana Government requested the United Kingdom to contribute towards the transport of Ghanaian troops as part of the United Nations' forces in the Congo, R.A.F. aircraft have been actively engaged in flying to the Congo. The original request was for the airlift of about 1,500 Ghanaian troops and police, along with vehicles and supplies, from Accra to Leopoldville.

Initially, Comets, Britannias and Beverleys of Transport Command were used, flying out from the U.K. by way of Pisa, Italy, and carrying food for the refugee centre which had been set up there. The first stage of the airlift was completed at the end of July, and on the return flights to the U.K. some British and Belgian refugees were carried. During the first operations the Comets logged 113 hr. 20 min., the Beverleys 83 hr. and the Britannias 70 hr.—a total of 266 hr. 20 min. They flew a total of 37 sorties, carrying 1,356 passengers and 60 tons of freight, plus 45 vehicles, between Accra and Leopoldville.

Aircraft of the Middle East Air Force and of the British Forces Arabian Peninsula were also engaged in flying food and supplies from Kenya and Cyprus to the Congo and evacuating refugees on the return flights.

In August, an R.A.F. detachment under the overall command of the A.O.C.-in-C., Transport Command, was established at Accra to maintain the Ghana force in Leopoldville. Two Hastings aircraft of No. 114 Squadron (Wg. Cdr. L. V. Craxton) from R.A.F. Colerne were allocated for this duty, along with supporting groundcrews at Accra and Leopoldville. The task provided for two weekly flights between Accra and Leopoldville in each direction, carrying a total of 15 tons of freight per week.

The first Hastings sortie was completed on schedule, carrying five passengers and 7,500 lb. of freight and mail to Leopoldville, and the service was thereafter maintained almost without a break. The last schedule on this service was flown on Nov. 4, by which time the two Hastings had carried, on the outward flights, 1,082 passengers, 99,185 lb. of freight, and 5,709 lb. of mail. On the inward flights to Accra the figures were 1,293 passengers; 17,367 lb. of freight, and 4,760 lb. of mail, together making a total of 2,375 passengers; 116,552 lb. of freight and 10,550 lb. of mail.

With the ending of the Accra-Leopoldville service (1,200 n. miles) the R.A.F. extended the route to Luluaborg (adding 460 n. miles) to continue the normal maintenance of the Ghana force, although the flights were still staged through Leopoldville as a refuelling stop. The Luluaborg schedule began on Nov. 5 and operated every third day. Up to Nov. 18, 182 passengers; 24,690 lb. of freight and 2,100 lb. of mail had been carried in both directions over the longer route.

On Nov. 23 the Leopoldville airport was closed by the Congolese National Army, and a Hastings en route had to be diverted to Brazzaville, where it was allowed to remain for 30 min. The political situation became acute and it was decided to evacuate the Ghanaian Police, Embassy staff and civilians from Leopoldville.

This evacuation began with two airlifts by Hastings, carrying 79 passengers, and a Britannia was flown out from Lyneham next day to assist. The evacuation was completed on Nov. 28, when 372 passengers and 1,500 lb. of freight had been lifted in three Britannia and four Hastings sorties. Including the flight to and from Lyneham the Britannia flew 16,851 miles in 45 hr. 40 min., the Hastings 10,258 miles in 44 hr. 45 min.

By the end of December, 1960, No. 114 Squadron had flown a total of 759 hr. 20 min. since the R.A.F. detachment was established at Accra. This squadron continued the service until Jan. 31, after which Hastings of No. 36 Squadron (Wg. Cdr. W. L. Green, D.F.C.), also from Colerne, took over.

R.A.F. Appointments

THE following are among recent Royal Air Force appointments:—

Air Ministry: Wg. Cdr. A. G. Steele, A.F.C., to the Department of the Chief of the Air Staff: Wg. Cdr. C. C. M. Baker, O.B.E., to the Department of the Air Member for Supply and Organization.

Bomber Command: Wg. Cdr. A. S. Pattie to Headquarters as Command Catering Officer: Wg. Cdr. R. E. Dyson, D.F.C., to R.A.F. Marham to command the Administrative Wing.

Fighter Command: Wg. Cdr. J. L. Jones to Headquarters for planning duties; Wg. Cdr. G. B. Masters to Headquarters for duty in the Air Defence Operations Centre.

Coastal Command: Wg. Cdr. E. D. Hills, M.B.E., to Headquarters as Senior Equipment Staff Officer.

Flying Training Command: Wg. Cdr. J. Segar to R.A.F. Linton-on-Ouse to command the Administrative Wing.

Maintenance Command: Gp. Capt. S. L. Swain to Headquarters, No. 40 Group, for equipment duties: Wg. Cdr. W. R. Brooks, D.F.C., to No. 25 Maintenance Unit, R.A.F. Hartlebury, for equipment duties; Sqn. Ldr. G. R. Hadfield to the Central Servicing and Development Establishment, R.A.F. Swanton Morley, to command the Weapons Wing, with the acting rank of Wg. Cdr.

R.A.F. Germany: Wg. Cdr. E. C. Ashley, O.B.E., to Headquarters for signals planning duties.

Other Appointments: Wg. Cdr. R. F. T. Doe, D.S.O., D.F.C., to the Ministry of Defence for duty with the Chiefs of Staff Committee and Secretariat; Wg. Cdr. J. H. Hoskins, D.S.O., D.F.C., to Supreme Headquarters Allied Powers Europe for operations duties; Wg. Cdr. J. G. Wynne, D.F.C., to the United States for exchange duties with the U.S.A.F.; Wg. Cdr. W. J. Marriott to the Pakistan Air Force Staff College for directing staff duties.

More Service News

No. 84 Squadron.—A reunion of No. 84 Squadron will be held at the Artillery Arms, Rochester Row, S.W.1, on Saturday, Mar. 11. Further particulars are available from Mr. Owen Greenwood, Flat 24, 62 Belgrave Road, London, S.W.1.

Coming of Age.—The Potters Bar branch of the R.A.F. Association is planning to celebrate the coming of age of the D.H. Mosquito with a ball at Salisbury Hall, London Colney, on Jne. 24. The branch hope that many people, both ex-aircrew and those who worked on the project, will attend the celebration which will have the original Mosquito as its centrepiece. Further details may be obtained from Mr. R. J. Shelley, 2 Westwood Close, Potters Bar, Middlesex.

AIRCRAFT SYSTEMS AND SERVICES

Many complex internal systems form an integral part of the modern civil or military aircraft. These essential services embody new techniques and equipment which have been developed by specialist companies in a large ancillary industry. In the following 12 pages the latest development trends in the major aircraft systems are reviewed by specialists.

Trends in Flight Control Systems

by K. Fearnside,* M.A., A.M.I.E.E., A.F.R.Ae.S.

FLIGHT control systems in current use and accepted by aircraft operators as an essential part of any large transport aeroplane can normally be sub-divided into either two or three parts, the flight instrument system, the automatic pilot and, in some cases, the autostabilizer.

The flight instrument system is normally a twin system having identical indicators on the captain's and first officer's sides of the cockpit. Most of the information displayed by the system is integrated into two instruments. The first of these normally provides attitude information and director instructions for steering on to any required course or radio beam. In other words, the instrument both informs the pilot of his present situation and tells him what to do about it. The second instrument is fundamentally a compass card displaying in its centre navigational information from radio guidance systems.

It is usual for the flight instrument system to be coupled to the autopilot so that manœuvres such as holding patterns can be followed by the manual insertion of instructions into the instrument system and so that the same instruments may serve as a monitor for the performance of the autopilot. The two pairs of instruments, port and starboard, are usually fed by independent directional and vertical gyros and electronic computers.

The essential information that they display is continuously monitored by a comparator which signals a warning to the pilot in the event of the two parts of the system disagreeing by more than a permitted amount. The pilot is able to determine by a reference to simpler standby equipment (such as a magnetic compass) which part of the flight system is defective and switch it out of service or disregard it.

The autopilot provides for the stabilizing of the aircraft in any required normal attitude and provides facilities in azimuth for carrying out turns on to preselected headings, or turns at a preselected bank angle, and for coupling to VOR radials or to an ILS localizer beam. In pitch, facilities are normally provided for attitude holding, for flying at a constant height or a constant indicated airspeed and, in addition, for coupling to the ILS glide path. The equipment is, therefore, capable of continuous use from shortly after take-off until the end of an ILS approach.

To ensure the safety of the aircraft in the event of an autopilot malfunction the authority of the latter is limited. For example, the autopilot may be prevented from deflecting the control surfaces by more than a known safe angle or alternatively from exerting a torque which is greater than a permitted value. This limitation in authority may carry with it a restriction in autopilot performance since in some circumstances more than the permitted amount of authority over the control surfaces would be required in order to carry out the desired manœuvre satisfactorily.

In many of the high-speed jet aircraft now in service additional artificial damping (autostabilization) is required in order to assist the pilot to fly the aircraft manually. Although it is possible to fly such aircraft manually the aerodynamic damping present, particularly in yaw, is very small and this means that in turbulence the task of flying such aircraft for long periods is very exhausting for the pilot. Yaw dampers are, therefore, fitted and are normally carried in duplicate so that in the event of one yaw damper system failing a second is available.

Trends in the design of flight instrument systems in the next generation of aircraft will be influenced by one major development, the provision of automatic landing. There are also a number of other trends which are valuable in themselves—apart from their final embodiment in the automatic landing manœuvre.

The first is towards a very much closer integration of the flight instrument system and the automatic pilot. With the degree of reliance being increasingly placed on the flight instrument system and the autopilot, the inelegances in their performances must be progressively reduced so that while the autopilot is functioning satisfactorily the flight director index is essentially at zero and a source of reassurance to the pilot. In current systems this is by no means always the case.

The second major trend is towards more and more accurately controlled autopilot facilities. These may include for instance:—

The automatic control of descent so that it can be carried out at a constant rate.

Automatic rejection of VOR coupling over the zone of confusion around the station.

Control so as to fly at constant Mach number.

Automatic acquisition of the ILS glide path.

Automatic control along preselected tracks derived from Doppler and compass information.

The third trend is towards closer tailoring of the flight control system to the individual aircraft than has been necessary up to the present. Aircraft are rapidly increasing in performance and as a result they are increasingly difficult to control.

An adequate level of autopilot performance can only be obtained by very careful attention to the installation of the sensors from which input signals are derived and the servos by means of which the control surfaces are operated. The former requirement has led *inter alia* to the development of air

*Director of Research and Engineering, Smiths Aircraft Instruments, Ltd.

AIRCRAFT SYSTEMS AND SERVICES . . . .

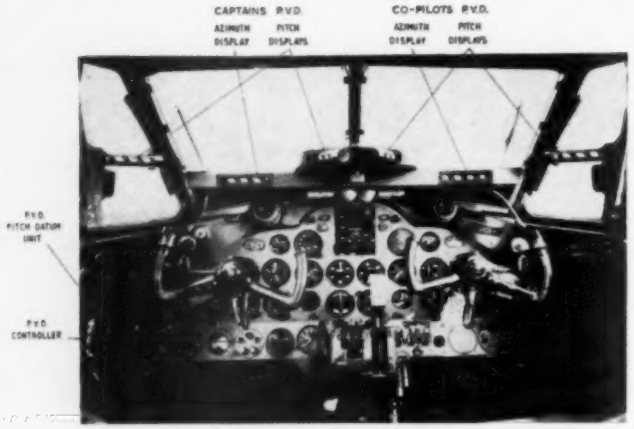


Fig. 1. P.V.D. installations in a D.H. Dove.

data computers which derive all the required manometric signals for the instrument displays and the autopilot from a single set of pitot static heads.

A fourth trend of major interest lies in the development of new forms of flight director. Consider the case of a pilot flying a critical manœuvre from a flight director such as an approach in poor visibility. His attention may well need to be removed from the instrument which he is fixating, i.e., looking at directly, for periods of time.

He may, for example, wish to look out of the window. He may wish to look at other instruments inside the cockpit.

If the manœuvre being flown is critical in nature it is highly undesirable that flight director information should be interrupted for a single instant. The problem of supplying flight director information in these circumstances has been tackled in two ways.

First a number of devices are under development for the projection of flight director information on the windscreen in front of the pilot's eyes. This deals with the problem, provided that the pilot is looking straight ahead out of the window. For those intervals when his attention is inside the cockpit and not on the flight director, the problem remains.

The second way of supplying flight director information overcomes this difficulty of attracting the pilot's attention wherever it happens to be concentrated. The signals are so compulsive that they can be seen and obeyed even though the pilot is not looking at the director.

This principle which depends upon extrafoveal vision is incorporated in the Smiths Para Visual Director (P.V.D.), described in THE AEROPLANE AND ASTRONAUTICS, May 13, 1960, page 579. It is sufficient here to say that it can provide an input of flight director information, or of autopilot monitoring information when the flight director is used in that rôle, even though the pilot is looking inside the cockpit or outside it, over a solid angle of about 70° about the nose. This particular flight director is going to be of great help in solving the problems of automatic flare and automatic landing. Fig. 1 shows a typical P.V.D. installation.

The major step forward in the next generation of flight control systems is, however, the provision of facilities for automatic landing. An automatic landing system for the R.A.F. has been under development by Smiths Aircraft Instruments in conjunction with the Blind Landing Experimental Unit of the Ministry of Aviation for some years and is now in production.

Essential principles of this system are that it is based on an automatic ILS approach, and that in the final phases before landing azimuth guidance is provided by leader cables, and pitch guidance by means of a radio altimeter carried in the aircraft. Provided that normal ILS facilities are available, therefore, the only additional ground equipment required at an airport at which an automatic landing is to be made is the installation of leader cables. The possibility of using ILS localizers of improved design to provide azimuth guidance throughout the landing operation is now being investigated, and the installation of leader cables may by this means be avoided.

Equipment being produced for the R.A.F. is, however, by no means able to meet the safety requirements for civil automatic landing. It is based on an autopilot similar to the Smiths S.E.P.2 and from statistics gained from more than a million flying hours in airline operations this automatic landing system would have a probability of a malfunction about 4×10^{-5} per landing.

The requirement for a system to be used for civil automatic landings is likely to be a malfunction rate at least as low as 1×10^{-7} per landing, and the design target must be at least an order of magnitude better. Further, the flight instrument system and autopilot must be so designed as to show very clearly at each stage of the operation that all the equipment on which the operation is based is working satisfactorily, so that the pilot is at all times fully aware of the state of his equipment and can at any time decide to discontinue the operation or to change its nature at his discretion. The equipment must also be easy to test thoroughly in the normal turnround times available.

SCALE OF EQUIPMENT		PROBABILITY OF	
SUB-CHANNELS FOR EACH AXIS OF CONTROL	SOURCES OF RADIO GUIDANCE	ARRIVING AT 200ft. UNSERVICEABLE FOR AUTOMATIC LANDING	MALFUNCTION DURING LANDING IF FULLY SERVICEABLE AT 200ft.
1	1	$2{\cdot}4 \times 10^{-2}$	4×10^{-5}
2	2	$2{\cdot}4 \times 10^{-2}$	$6{\cdot}7 \times 10^{-5}$
3	3	$1{\cdot}2 \times 10^{-3}$	$3{\cdot}3 \times 10^{-9}$

Fig. 2. Probabilities of malfunction in automatic landing auto-pilots.

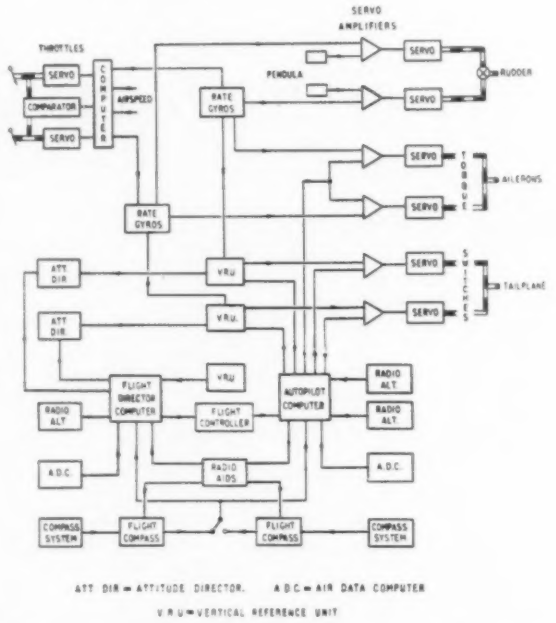


Fig. 3. Simplified block diagram of integrated flight control system for the D.H. Trident.

Based on the experience they have gained in experimental flying with the B.L.E.U. system, Smiths have for the past four years been engaged on the design of a second generation system which would meet the very stringent requirements for civil automatic landing. Experience has shown that it is extremely unlikely that these requirements can ever be met by a single-channel autopilot and it was decided by the company some four years ago that the only completely satisfactory way of meeting all the requirements was to adopt a multiplex system.

This is an automatic control system having more than one control sub-channel for each axis of control and in which all such sub-channels operated together except in the event of a malfunction. In the event of any sub-channel in one control channel passing outside the limits of its permitted tolerances, arrangements are made for this channel to be disconnected and the pilot to be warned.

To carry out an automatic landing operation it is thought that the system should be triplex, i.e., have three sub-channels for each control channel. As an example, consider pitch control during the flare manœuvre. In this case, each sub-channel consists of a radio-altimeter, a pitch computer, a rate gyro, a

servo-amplifier and a servo-motor, which includes a torque comparator unit.

The three sub-channels are controlled by independent switching circuits and are supplied from independent power supplies. The torque comparison between the sub-channels is effected mechanically at the point where they are connected to the aircraft control runs, so that a failure in any part of the sub-channel or the associated power is detected by comparison at this point.

In the absence of a fault the entire equipment is working in its normal mode, and in overcoming fault conditions a complete sub-channel is rejected. The operation of rejecting a faulty sub-channel can be made very secure as it depends only on breaking circuits and not on making them. And, in the unlikely event of a failure in the disconnect arrangements, the system is designed so that two normal sub-channels can continue to operate the control runs satisfactorily against any torque exerted by a faulty sub-channel.

Adoption of the multiplex principle has brought in its train a number of difficult engineering problems, particularly those of ensuring that the sub-channels will work together under all normal operating conditions without causing nuisance cut-outs. However, these have been accepted and overcome in the interests of providing equipment which meets the overriding requirements of being demonstrably safe for the purpose. As detailed development proceeds, it appears that the complexity of the resulting equipment is not likely to be greater than the other solutions which were considered and discarded and, of course, a system may be extended in multiplicity to any required extent without raising new basic problems.

The forecast probabilities of system malfunctions are shown in Fig. 2, from which it will be seen that the triplex system should provide an adequate margin over the figure of 1×10^{-7}.

Experimental multiplex systems were first flight-tested by Smiths two years ago and the first production equipment will

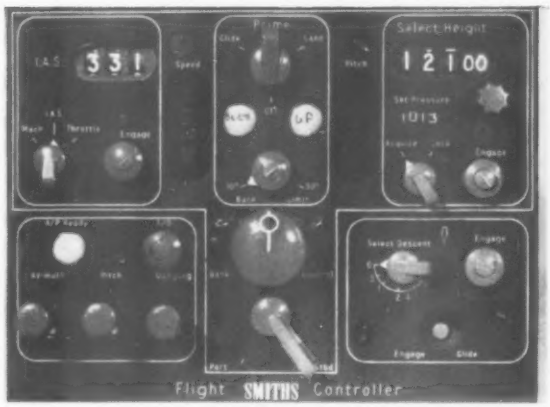


Fig. 4. Trident flight controller.

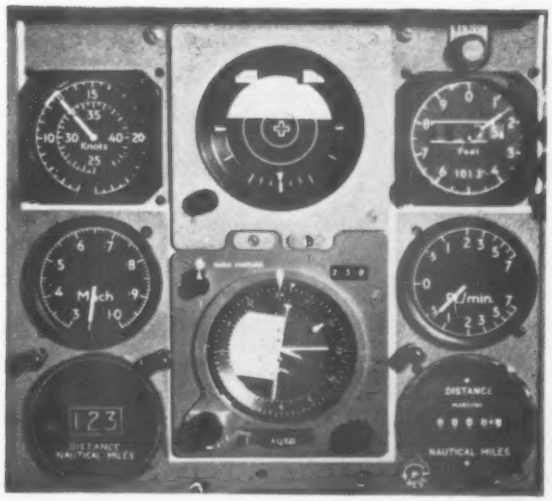


Fig. 5. Trident flight instruments.

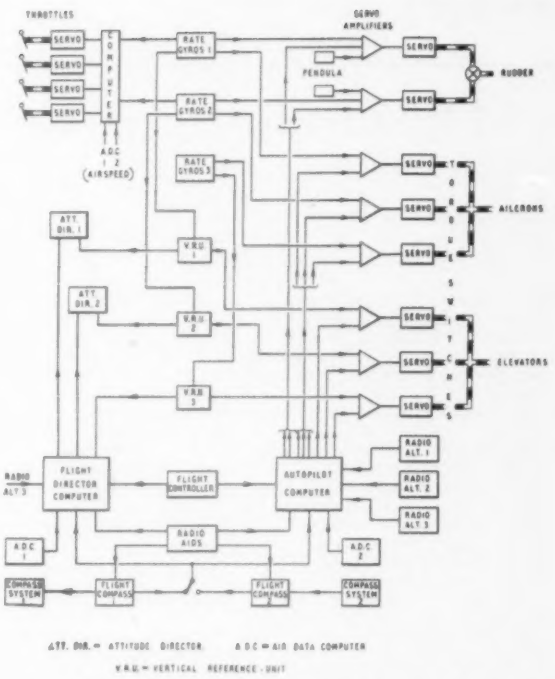


Fig. 6. Block diagram of a triplex flight control system.

be fitted to the de Havilland Trident aircraft being built for British European Airways. This flight control system embodies the design trends mentioned earlier in this article, and will initially be fitted at duplex level, to provide only automatic control of flare. A block diagram of this system is shown in Fig. 3, and the control panel and instruments in Figs. 4 and 5.

The control of both flight systems and autopilot has been completely integrated on this control panel which incorporates a comprehensive range of functions to be selected by the pilot for autopilot or flight director control. An additional novel feature of the system is the facility for control of airspeed by automatic operation of the throttles. This enables approaches and landings to be made with an accurately controlled airspeed, and will assist in improving the precision and safety of landings whether manual or automatic.

The significance of automatic flare control lies in the fact that during approaches to land under limiting weather conditions and in the dark, the guidance in azimuth provided by the normal pattern of runway lighting is much superior to the guidance available in pitch. It follows therefore that the pitch axis can with advantage be controlled automatically while the pilot continues to control the aircraft in azimuth.

It is envisaged that at the normal break-off height the pilot will disengage the roll channel after completing an automatic approach and will himself fly the aircraft in roll while the automatic pilot continues to fly in pitch. Because the visibility must be such as to provide normal azimuth guidance, the pilot can take over at any point after the normal break-off height should he wish to do so. The aircraft, it will be noted, is fitted with a Para Visual Director which supplies the pilot with independent guidance in both pitch and roll which he may use in the event of his having to disconnect the autopilot during the later stages of the approach.

When confidence has been built up on the automatic flare function of the autopilot, the equipment may be very simply extended to automatic landing by adding a number of components of similar design to those already in the system and the conversion will be a relatively straightforward and inexpensive matter. A fully triplex system such as will be used in the R.A.F. Belfast aircraft is shown in Fig. 6.

This article has described very briefly the trends in flight control system design for the next generation of civil transport aircraft. In this field, and particularly in the application of automatic landing, the United Kingdom has built up a considerable lead over the rest of the World. Interest in automatic landing is, however, growing rapidly, particularly in the United States, and very determined action will be necessary over the next few years if Britain is to reap the economic benefits of her pioneering work in this field.

AIRCRAFT SYSTEMS AND SERVICES . . . .

Developments in Aircraft Hydraulic Systems

by A. A. J. Willitt,* D.C.Ae., A.F.R.Ae.S.

A MEASURE of the growing part played by hydraulics in the control and operation of aircraft is the total installed horse-power which is, in general, taken from the engines by pumps and converted to hydraulic power for distribution throughout the aircraft. Fig. 1 shows the growth of installed horse-power over the years partly due to aircraft becoming larger, but mainly because hydraulic power is being increasingly utilised. It is not uncommon to find an installation of well over 100 h.p. in today's aircraft.

This increased power demand comes chiefly from the adoption of control surface actuation by hydraulic power and the need to duplicate these systems which are of vital importance to the safety of the aircraft. Because of the high acceleration of jet fighter aircraft after take-off, it is now necessary to retract the undercarriage and close the fairing doors to the clean position in three to four seconds before the aircraft accelerates to a speed greater than that for which the undercarriage is designed to operate.

High-lift devices, to offset increased wing loading, involve the movement of large surface areas, both at the front and the rear of the wing. These have to be moved in sychronism and without the possibility of asymmetric failure, which would put the aircraft out of control in roll. Vertical take-off aircraft with movable engines depend on hydraulic power to tilt the massive engine assemblies during transition.

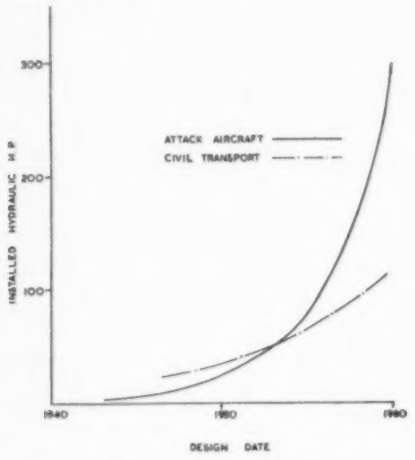


Fig. 1. The growth of hydraulic power.

These are some of the more obvious uses for the hydraulic system. There are many less conspicuous duties to which it is put—namely, driving fuel booster pumps, cabin blowers, cargo winches, air stairs and even moving the pilot's cabin bodily, so that he can see over the nose of the aircraft during landing. There is in fact no shortage of tasks to which the aircraft designer can apply the hydraulic system.

System Cooling

This increase in horse-power gives rise to the first significant change in system design, i.e., the addition of a cooling system. For a long time hydraulic systems were naturally cooled by heat dissipation from the reservoir and piping. Now air to oil or fuel to oil coolers have become standard fitments to dissipate the increased heat load which has not been balanced by increased dimensions of the hydraulic system.

Aerodynamic heating of high-speed flight will, in general, prohibit the use of air coolers. The most popular alternatives are to transfer the heat to the fuel system or, alternatively, dissipate it by means of water evaporation.

System Pressure

Systems operating at 3,000 p.s.i. are well-established in Europe and the U.S.A. More than half the British military aircraft use 4,000 p.s.i. systems, as do a few recent aircraft in the U.S.A. Aircraft designers have been reluctant to accept higher pressures but where the battle for weight and—in some cases more important—space, has necessitated the use of 4,000 p.s.i. systems, these have proved to be no less reliable than the well-established 3,000 p.s.i. systems.

The need to develop systems to work at higher temperatures for supersonic flight will inhibit the trend to higher pressures for the time being. However, systems engineers estimate that for the larger aircraft (around 200,000 lb.), minimum weight is achieved at pressures in the order of 7,000 to 8,000 p.s.i. Whilst there would undoubtedly be difficulties, systems could be designed and constructed to operate at such pressures where the size of the aircraft and the loads involved are large enough to make possible the economic use of these higher pressures.

With smaller aircraft, say of the size of the Hunter, minimum weight occurs around 4,000 to 5,000 p.s.i., but it would require careful matching of the airframe and system to realise the full weight saving, although space limitations rather than weight may be the criterion. Very thin wing surfaces and the avoidance of external hinges may force the designer to higher pressures to keep the actuator equipment within the aircraft envelope.

Fluids

New fluids have and are being developed to replace the well-known red hydraulic oil DTD.585 (MIL-5606) which is still in world-wide use with the majority of military and civil aircraft. Due to the requirement to operate at higher temperatures and the need for greater safety, other fluids now challenge its supremacy. It is not possible here to discuss all the new fluids, and the reader is referred to A. E. Bingham, I.Mech.E. Proc.: 1951, Vol. 165 (WEP69) for more details.

To mention two, the first is Skydrol 500, a fire-resistant fluid which is being used in a number of current American civil aircraft and just beginning to be used in European-built aircraft. Skydrol requires care in use, because of its attack on electric cable insulation and paint. Industry is still awaiting an elastomer sealing material compatible with Skydrol 500 and having the same resistance to wear and extrusion as have the nitrile seals used with DTD.585.

Second, a contender for both the fire-resistant category and high-temperature operation is DP.47 by I.C.I. (GE.81406 in the U.S.A.). This new fluid again has its problem of finding a compatible elastomer sealing material for the construction of glands, as the majority of known compounds shrink heavily when soaked in the fluid, causing severe dimensional changes to the seal and consequent leakage.

However, in connection with high-temperature operation, a successful experimental development has been carried out using Viton sealing material. The test results show good promise for operation of fairly conventional hydraulic systems over a temperature range from −26° C. to about +200° C., although, for the present, with a rather shorter seal life than is experienced with contemporary hydraulic systems.

In connection with guided weapon applications, test runs of a few hours' duration have been carried out on servo valves and actuators at 700°F. In these tests Viton rubber was used for low-pressure seals only. High-pressure static seals were all metal and high-pressure dynamic sealing was by close-fitting labyrinth. Research is actively directed at new sealing materials, also for additives to the fluid to make it easier to use and to improve its present poor lubricating properties.

It is not generally appreciated that hydraulic fluids wear out. Fluid, which is pumped at high pressure through small clearances, suffers a marked permanent reduction in viscosity. This change in viscosity alters the timing of circuits controlled by viscous resistance and, under some conditions of operation, is a measure of the reduction in lubricating properties.

By way of example, DTD.585 pumped at 4,000 p.s.i. through a small orifice, is halved in viscosity in under 200 hr., a feature

* Chief Engineer, Dowty Rotol, Ltd., Arle Court Division.

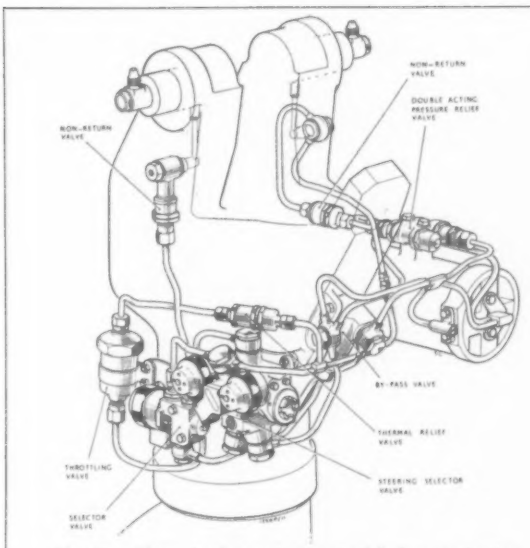


Fig. 2a. Nosewheel steering control before packaging.

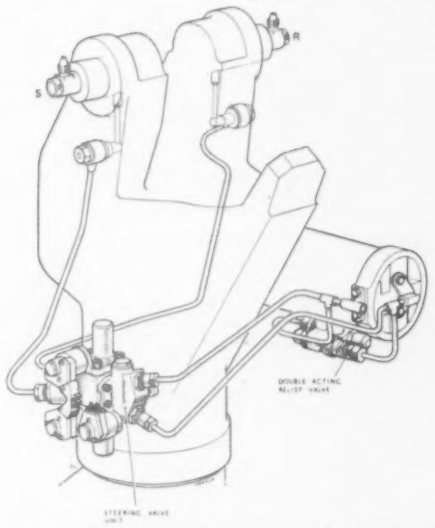


Fig. 2b. Nosewheel steering control after packaging.

to be considered in the acceptance of new fluids. In the development of pumps and servo units to operate with these new fluids, it will be necessary to specify and test at the minimum viscosity which will be encountered in service. Viscosity and chemical changes will limit the life of hydraulic fluid when operation at high temperature is continually required.

Dirt Contamination of Systems

Because earlier generations of hydraulic systems were extremely tolerant to dirt contamination, aircraft constructors and users are reluctant to admit the need for reasonable care and attention to the cleanliness of aircraft hydraulic systems. The high-powered hydraulic system of today, designed for precision operation of controls and powered by high-speed lightweight pumps, needs reasonably clean fluid on which to function efficiently, and the degree of contamination cannot be left to chance.

Aircraft constructors and operators can meet the required standards of system cleanliness with little additional effort, effort which will be handsomely repaid in reduced early component removal during acceptance tests and reliable operation of the aircraft in service. The standard American procedure for measuring system contamination, as laid down in ARP.598, gives a simple and reliable method of establishing whether constructional methods are giving a satisfactory standard of cleanliness.

The following precautions are recommended in the building and servicing of aircraft:—

1. Thorough cleaning of all pipe assemblies and sealing of these assemblies until the system is complete.
2. Storage of all components as sealed by the manufacturer until fitted to the system.
3. Regular cleaning and contamination checking of all functioning rigs on which components or systems will be tested.
4. Pre-cleaning of the aircraft system by circulation on large external slave filters and pumps before fitting precision hydraulic components.
5. Pre-cleaning of all hydraulic fluids including new fluids before filling systems. Filling should only be carried out through a pressure-charging connection not by open filler caps.
6. Contamination level measurement of the complete hydraulic system.

Experience shows that, other than in the case of mechanical failure of components, very little contamination is generated within the system. The bulk comes from the original build of the aircraft and the subsequent admission of dirt when component changing. If reasonable system hygiene is exercised, the aircraft need only have filters of small capacity to deal with the low level of contamination generated by component wear and unavoidable contamination when servicing.

It is suggested that system contamination measurement need only be made when the aircraft is first built, after major overhaul or following cleaning, subsequent to component breakdown. A suggested standard of contamination tolerance is defined in Table 1.

For research, or during development of new aircraft, contamination measurement which allows the determination of both quantity and the nature of the contaminant, is a valuable "look inside" to detect excessive wear and forestall expensive breakdowns.

TABLE 1—Suggested Allowable Contamination Limits for Aircraft Systems

	Fibres	Over 100μ	50–100μ	25–50μ	15–25μ	5–15μ
Initial comtamination	13	Nil	20	1,000	5,000	15,000
Contaminated limit	3	5	60	3,000	15,000	45,000

Miniaturization and Packaging

The design trend in hydraulic components is, of course, as with all other aircraft components, miniaturization and packaging. Miniaturization is yielding good results on system components, by the use of refined designs and manufacturing techniques.

Pumps and hydraulic motors are additionally being miniaturized by operation at high speed. Hydraulic actuators can only be miniaturized by higher system pressures, but valuable weight savings are being achieved by the use of new materials and by the optimization of installations with respect to working load and stroke.

Complete system packaging is familiar in guided weapon construction, but it does not lend itself entirely to aircraft construction because of the diversification of services throughout the airframe. Nevertheless, successful packaging is being applied to groups of components which would otherwise be located in a fairly close proximity. Examples of this are the integration of selector valves, their associated non-return valves and thermal relief valves.

Figs. 2a and 2b show a package of components required for a nosewheel steering system and a comparison with their original layout as individual components. Figs. 3a and 3b show a remarkable example of packaging in servo controls where one unit has replaced two. A manually controlled surface actuator and an electrically controlled auto-stabilizer actuator, have been integrated into one package with remarkable savings in installed weight and improvements in performance.

Packaging of components saves weight, makes for easier airframe installation and servicing, and improves reliability by eliminating system joints.

Engine Starting by Hydraulics

Whilst hydraulic engine starting is not new, Vickers Detroit have recently re-demonstrated the practical application of hydraulic starting to the modern jet engine. On the ground, a hydraulic power source is used in a manner similar to an electric ground starter trolley. Once a single engine has been started, the aircraft's hydraulic system can be utilized to start the remaining engines. The use of power from the aircraft system is particularly advantageous for starting engines in flight, as is

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necessary with VTOL aircraft which have separate engines for vertical flight.

A logical extension of this principle is the use of a combination starter and hydraulic pump. Since these duties are very similar, it is possible to make a unit which will rotate the engines for starting when provided with an external power supply and, in flight, the same unit will generate hydraulic power for use by the aircraft hydraulic system.

Electrical Control of Hydraulic Systems

In the early days of hydraulic systems, electrical operation was the alternative and rival to hydraulic actuation. Today, with the general increase in power levels, hydraulics and electrics have found their natural places and are no longer in competition except on the smallest of aircraft. On all recent installations there is a happy marriage in the use of electrics for signalling and control of hydraulics.

Until recently, this electrical control has been limited to On/Off control, i.e., solenoid operation of hydraulic valves. These have been successfully applied to the positional control of nosewheel steering and flap operation as On/Off servo controls, and are of particular merit for control systems where the load also involves a high level friction as in nosewheel steering.

The guided weapon has brought with it the practical development of electrically controlled proportional servo valves, i.e., valves in which the flow or pressure of hydraulic fluid is proportional to the applied electrical signal, as distinct from the mere selection of On/Off flow. A typical valve of this type, —the Dowty Moog valve—has opened up new fields of hydraulic operation, making possible extreme precision positional or speed control of actuators. This servo valve is a wonderful example of miniaturization. A unit weighing only 11 oz. will control servo circuits of up to 20 h.p. and requires input command signals of only 50 mW., i.e., a power gain of a third of a million to one.

Control Surface Actuators

The previously mentioned electrically signalled servo control valve makes possible impressive developments in the design of control surface actuators. The extremely low input/power level and the use of internal mechanical feedback techniques simplifies the electrical control system and has made possible an integrated actuator which accepts either mechanical command signals from the pilot and/or electrical command signals from auto-stability control, auto-pilot or ground command. These mechanical and electrical signals can be accepted independently or mixed algebraically, and the percentage of command available to the electrical signalling channel can be regulated in accordance with the flight regime—Fig. 3b.

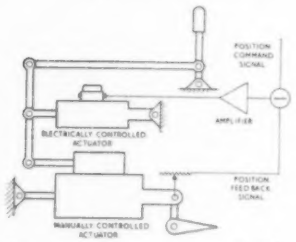


Fig. 3a. Right, diagrammatic installation of unpackaged and packaged control surface actuators.

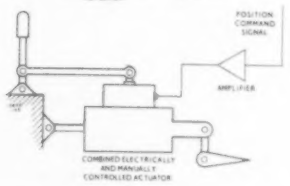
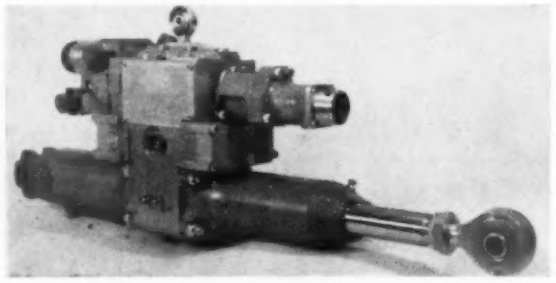


Fig. 3b. Below, packaged control surface actuator for mechanical and electrical signalling.



Aircraft Systems Trainers

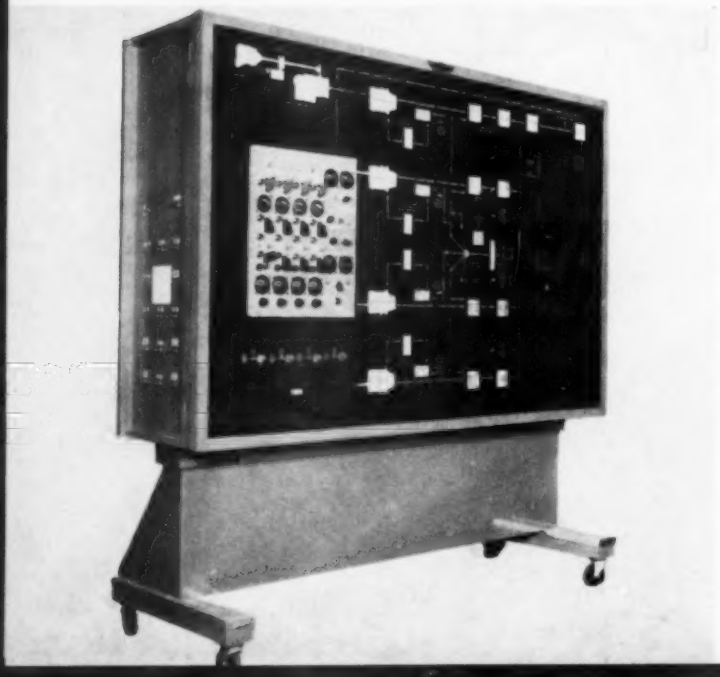
BECAUSE of the complexity of the internal systems in the new generation of civil and military aircraft, it has become necessary to use specially designed classroom aids for training flight and ground crews in their layout and operation. It is, of course, possible to employ the conventional training techniques using wall-charts, photographs and written descriptions. But when it comes to a complex system having a number of operating modes such a technique is, to say the least, cumbersome. It becomes even more so when it is applied to the demonstration of the effects of faulty operation.

These considerations have led to the development of sophisticated simulator-type aids which may in themselves tend to be complex but which lead, in the long run, to a "streamlined," training programme both in terms of time and overall cost. A company producing equipment in this particular field is General Precision Systems, Ltd., of Aylesbury. The accompanying illustration shows a typical example of their range of systems training aids—it covers the electrical generating system for the Boeing 707.

These G.P.S. systems trainers are self-contained units. They comprise an animated display of the system activated by the operation of appropriate switches and controls which are grouped on panels similar to those of the aircraft concerned. This enables the trainee to familiarize himself with the layout of the controls and with the operation of the system.

System malfunctioning and the development of component faults can be simulated. These are introduced by means of additional controls adjacent to the main display.

One of the principal features of these trainers is that they can be operated by the pupil without the assistance of an instructor—which means that they can be used for revision and private study. They incorporate a jacking system so that the display can be raised or lowered; and the whole unit is mounted on castoring wheels for ease of movement from one classroom to another. All that is required to power one of these trainers is a single-phase domestic AC electrical supply.



This systems trainer developed by General Precision Systems Ltd. is used for instruction on the Boeing 707 electrical system.

AIRCRAFT SYSTEMS AND SERVICES . . . .

Trends in Aircraft Generating Systems

by J. C. Rivett, B.Sc.(Eng.), M.I.E.E.*

IN the modern aircraft the electrical system is of paramount importance. The increasing reliance of all aircraft systems on electrical or electronic components has resulted in intensive research and development of generating systems to meet the power requirements under all operating conditions.

The four main types of generating systems flying in British aircraft today are the 28-volt DC, 112-volt DC, 200-volt AC three-phase 400-cycle constant-frequency, and 200-volt AC three-phase variable-frequency system. The first and third of these systems are in increasing use.

A 112-volt DC system is in many ways very attractive, but has two main disadvantages. The first is the unsatisfactory operation of the commutator and brushes at this voltage, and the second is the need to provide a circuit breaker which will successfully break very high fault circuits.

The only advantage in using the 200-volt AC three-phase variable-frequency system is that the constant-speed drive is eliminated, but in return it incurs an even greater penalty of weight in order to make the generators and associated control equipment capable of generating over the frequency range. In addition, since the individual generator cannot be paralleled, penalties of weight and complexity of control gear have to be paid in order to permit the load to be switched automatically.

For these reasons, therefore, and with the reservation that in the normal process of development it may be possible to make either of the above systems more attractive, more detailed consideration can be given to the 28-volt DC and the 200-volt 400-cycle constant-frequency systems. These latter are complementary and not rivals, and will long remain with us.

The conventional DC generator which forms the basis of the 28-volt system cannot be successfully ram-cooled at altitudes in excess of 50,000 ft. and at speeds below approximately Mach 0.75. Within these limits, however, there are only two disadvantages with this type of generator. First, it is extremely difficult to construct a commutator that will maintain its concentricity under thermal and centrifugal stresses at a speed of about 10,000 r.p.m. Secondly, no satisfactory brushes for operation under the low humidity conditions associated with high altitudes have been evolved.

The 28-volt DC system of the future, however, is likely to overcome these difficulties by the use of brushless generators. Apart from the elimination of the commutator and brushes such machines have the advantage that they are lighter than the conventional generator and can be designed to give a low pressure drop of the cooling air which makes them suitable for use with ram-cooling at high altitudes. Their principal disadvantage is that it is not possible to achieve an output as free from ripple as that from the conventional generator.

Despite this, however, the brushless DC machines provide an attractive and reliable alternative to the commutator machines. It would appear likely that they will replace conventional generators in all future DC systems.

For various reasons—cost, and the inevitable demands for a substantial amount of DC are two of them—the 200-volt AC three-phase, 400-cycle constant-frequency system is not competitive with a 28-volt DC system in the smaller sizes. But for generating systems of 20 kVA and more for each channel, the AC system is to be preferred.

In the 200-volt AC three-phase constant-frequency systems, the AC generators have to be driven at a constant speed in order to achieve a constant output frequency and since the speeds of aircraft engines vary it is necessary to interpose some form of constant-speed drive between the engine and the generator. To date the constant-speed drives employed on British aircraft are of the hydraulic type and by far the most successful of these consist of a swash-plate pump and motor used differentially to add or subtract speed.

Other possibilities exist. For example, at the present time work is proceeding in this country on a differential air drive using a positive displacement motor driven by an air supply from the engine. For systems where paralleling is not required this will probably be successful, provided that a suitable high-temperature air-motor can be developed, and provided of course that the engine is capable of supplying air at a suitable pressure and quantity under all operating conditions. However, this unit will not be lighter than an hydraulic drive.

So far as the AC generator is concerned, the present practice is to use the brushless rotating rectifier type of machine and this unit is rapidly superseding earlier types which incorporate DC exciters with their attendant commutators, sliprings and brushes. Furthermore these machines, which are typical of current practice both here and in the United States, are capable of being cooled with a much lower air-pressure drop than that to which the aircraft industry has been accustomed, and are thus suitable for proportionately more severe duties.

Magnetic amplifiers for 200-volt. AC three-phase system.

From the introduction of the constant-frequency system up to the present day, the basic control and protective arrangements have remained virtually unchanged in principle. Important changes in detail, however, have been brought about by the advent of the transistor and have led progressively to an overall reduction in the weight of the control system, of which the accompanying figure is a striking demonstration.

It shows at the top, a magnetic amplifier regulator for a 200-volt AC three-phase, 400-cycle constant-frequency system together with its control panel in which calibrated relays have been replaced by individual transistor circuits, each giving its output at power level. Their total weight is 27¼ lb.

At the bottom is included a combined regulator-control panel which performs the same function but weighs only 13¼ lb., this reduction being achieved by integrating all the separate control functions. Printed circuits have been used extensively.

This review would be incomplete without an examination of the possibilities of producing constant-frequency power from AC generators running at a variable speed. It was not until the advent of the very large semi-conductors that static frequency changing became something more than a dream, but although this system has been demonstrated in a superficial way, a great deal remains to be done before it could be flown in an aircraft—or indeed before it has been demonstrated as desirable for aircraft use. None the less, much development effort is now directed towards these possibilities.

For the next decade, however, it is envisaged that for small aircraft a 28-volt DC system using brushless generators and transistorized control gear will be the most suitable system. For larger aircraft some form of constant-frequency system will prove the most acceptable.

This very brief review will, perhaps, convey some idea of the complexity of the problems inherent in the generating systems of aircraft. When the effects of ambient conditions—increasing in severity with every increase in speed and altitude—are added to this, the equipment manufacturer is faced with a problem which is very large in relation to the size of the aircraft equipment industry.

Indeed, were it not for the fact that in this country aircraft equipment is supported by the wider interests of the manufacturers concerned, they could not possibly carry the research and development facilities necessary. The results that have been achieved under these conditions are all the more remarkable.

* Deputy manager and chief engineer, English Electric Aircraft Equipment Division.

AIRCRAFT SYSTEMS AND SERVICES . . . .

Air Conditioning and Pressurizing Systems

SOME of the most difficult systems in an aircraft are those which cater for air-conditioning and pressurizing; for them the aircraft designer has to take into consideration many factors related to the rôle which the aircraft has to perform. This rôle is not only dependent on the stage length of the flight but on the areas over which the flight has to take place and the distances and altitudes involved. In addition to this, the way in which the operator utilizes the aircraft bears a very significant relationship to the type of systems that are involved.

In all cases it is first necessary to have a supply of air compressed to the pressure required to maintain the cabin at a suitable altitude below that at which the aircraft is operating. Additional pressure is required to overcome resistances of the ducting, control system and cooling units, etc., required to control the rate of flow and distribution of the air within the cabin.

After the air has been appropriately conditioned and supplied to the cabin, it is then necessary to have suitable discharge valves to maintain the pressure within the aircraft as required, and to give the necessary rates of climb and descent within the cabin. It is also necessary to provide inward relief valves to avoid external pressures being applied to the aircraft structure and outward safety relief valves to ensure that, in the event of malfunctioning of the discharge valve, internal pressures in the aircraft cannot exceed those for which it is designed.

With the advent of pure-jet high-altitude aircraft, it now appears that all types of aircraft will have to operate at altitudes of not less than 20,000 ft. and up to 40,000 ft. to avoid congestion at terminal airports. For this reason air-conditioning and pressurizing assumes a more important place in the design of an aircraft than hithertofore.

To give some indication of the types of air supply and conditioning system required for the cabins of modern aircraft, the accompanying diagrams show some systems that are applied to aircraft at present being used and designed. It will be seen from them that the choice of source of air also depends on many factors. With the later high-speed, high-pressure-ratio engines, however, it is becoming more economic to use independent cabin superchargers than to tap the engines themselves particularly as contamination problems with tapped engines are a hazard.

Fig. 1 shows a system applied to a long-range high-speed four-engined turbojet civil aircraft operating at altitudes up to 40,000 ft. with cabin altitudes not exceeding 6,000 ft. For this the air-conditioning comprises two similar systems, supplied independently from the port and starboard installation.

Four compressors are fitted, one on each engine; two of these supply the air to each system. Each compressor has its own automatic flow control so that only the required amount of air is fed into the system.

After leaving the compressor the air passes via a non-return valve into a metering duct, through a ram air cooled heat exchanger, non-return valves, stop valves and choke valves whence it is passed through the evaporator of a vapour cycle cooling pack and humidifier before entering the cabin distribution system. Heating is obtained by the operation of choke valves in the cabin compressor discharge line which loads the compressors and produces heat by compression.

The system shown in Fig. 2 is for a large four-engined turboprop aircraft of intermediate-range operation, with high-density seating, at altitudes up to 35,000 ft. with cabin altitudes not exceeding 8,000 ft. In this system two compressors are used for the source of air, and these are fitted to the auxiliary gearboxes of the inboard engines.

The air is ducted through primary silencers and non-return valves to a common duct and secondary silencer. It then passes into a flow controller and pressure relief valve to enter a by-pass valve dividing the air flow into two ducts, one taking warm air to the cabin and flight deck, and the other into the air cycle cooling system.

Air is passed through the ram air cooled primary heat exchanger, the compressor of a "bootstrap"-type cooling unit into the secondary heat exchanger (ram air cooled) and then through the turbine of the air cycle cooling unit where it reaches its lowest temperature. Before entering the distribution system it passes through a water extractor silencer for the removal of excess moisture and for silencing.

The temperature control, refrigeration by-pass, pressure sensing and feed back valves are connected electrically and are operated in conjunction with each other.

A system applied to a smaller twin-engined intermediate-

(*Continued on page 179*)

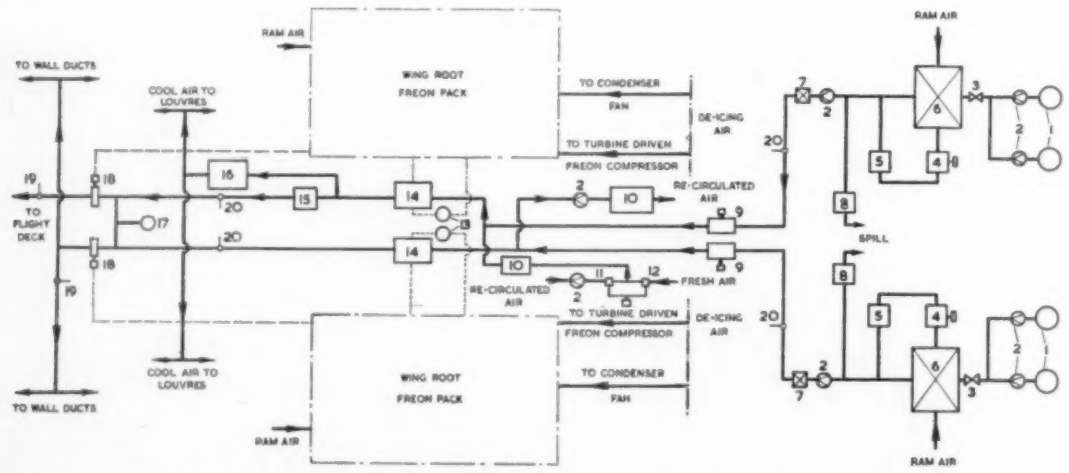
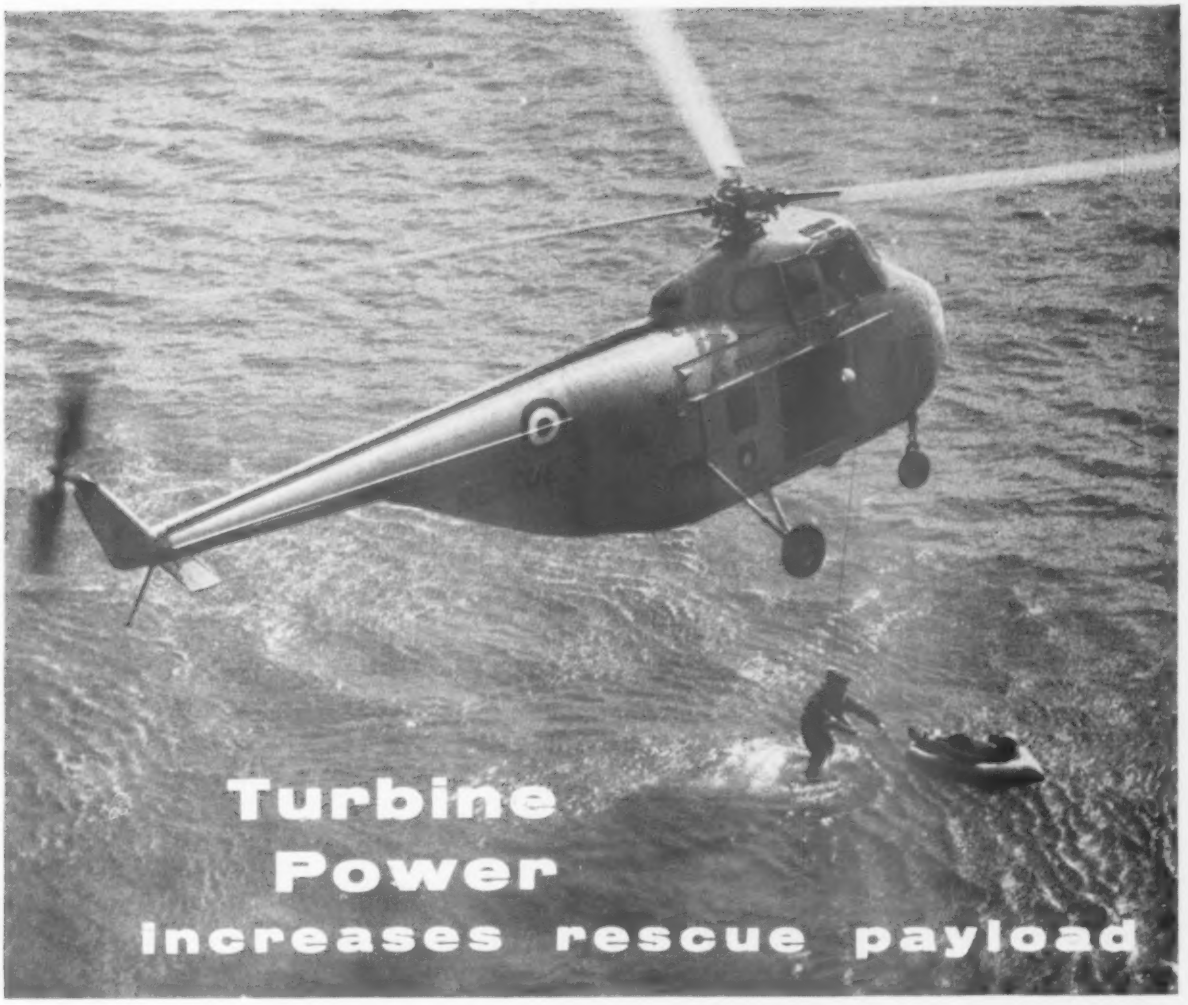
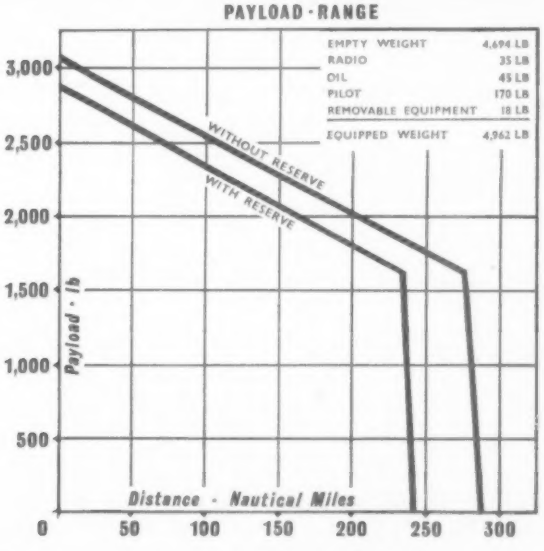


Fig. 1.

1. Compressors.
2. Non-return Valves.
3. Metering Ducts.
4. Cooler Modulating Valves.
5. Duct Relief Valves.
6. Heat Exchangers.
7. Stop Valves.
8. Spill Valves.
9. Choke Valves.
10. Circulating Fans.
11. Stop Valve.
12. Unpressurized Vent Valve.
13. Expansion Valves.
14. Evaporators.
15. Humidifier.
16. Louvre Fan.
17. Ground Connection.
18. Flow Balance Valve.
19. Duct Thermostats.
20. Overheat Thermostats.





The New Whirlwind Helicopter powered by the Gnome gas turbine engine has greatly increased power available at a much lower aircraft weight. The 1050 horse power of the de Havilland Gnome engine gives the Whirlwind exceptional high altitude and hot weather performance. The aircraft weight has been reduced by 650 lb. compared with the piston engined version. The Gnome Whirlwind can fly 90 miles, pick up eight survivors and return to base with ample fuel reserves. The engine power permits landing at 10,000 ft. with full load in conditions up to temperate maximum. Freight loads of 2,000 lb. can be carried or six stretcher patients together with a medical attendant. The large cabin makes the machine an ideal aircraft for a wide range of duties including 8-10 seat passenger transport, freighting, casualty evacuation, rescue and anti-submarine defence.

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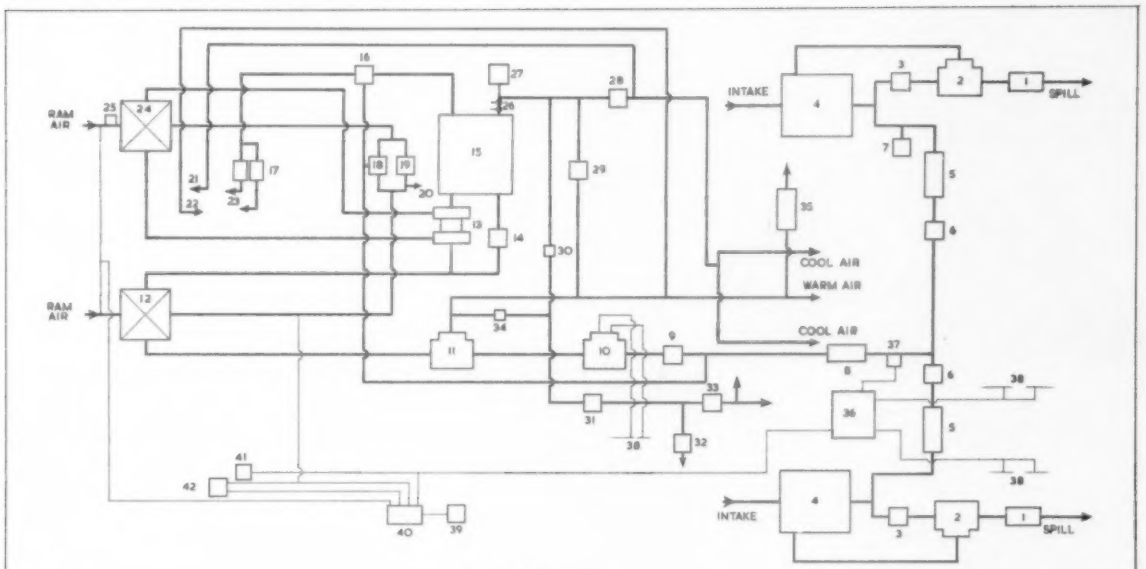


Fig. 2.

1. Spill Silencer.
2. Feed-back Valves.
3. Spill Valves.
4. Compressors.
5. Wing Silencers.
6. Actuated Non-return Valves.
7. Ground Connection.
8. Secondary Silencer.
9. Mass Flow Controller.
10. Duct Pressure Relief Valve.
11. Intercool By-pass Valve.
12. Primary Heat Exchanger.
13. Cold Air Unit.
14. By-pass Valve.
15. Water Extractor Silencer.
16. Auxiliary Heating Mixing Valve.
17. Heater Units.
18. Turbine Fan and Control Valve.
19. Check Valve.
20. Ram Air Outlet.
21. Flight Deck Cool Air Outlet.
22. Flight Deck Warm Air Outlet.
23. Flight Deck Auxiliary Heating Outlets.
24. Secondary Heat Exchanger.
25. Dump Valve.
26. Minimum Temperature Limiters.
27. Ground Connection.
28. Boost Fan.
29. Cross Flow Non-return Valve.
30. Non-return Valve.
31. Recirculation Fan.
32. Unpressurized Flight Valve.
33. Recirculation Check Valve.
34. Non-return Valve.
35. Wall Bag Ducts.
36. Discharge Valves.
37. Pressure Switch.
38. Static Vents.
39. Pressure Controller Air Filter.
40. Pressure Controller.
41. Swamp Valve.
42. Airport Altitude Selector.

(*Continued from page 178*)

range turboprop aircraft operating up to 20,000 ft. with a cabin altitude not exceeding 8,000 ft. is shown in Fig. 3. Air for ventilation and pressurization is supplied via two Roots-type superchargers, mounted on an auxiliary gearbox driven by each engine, and passes through silencers, spill valves and non-return valves to a common duct.

In this duct the air is fed through a duct relief valve and a choke heating valve whence it can take a path via the primary heat exchanger, or a water extractor and an anti-ice control valve, controlled by an anti-ice thermostat sensing upstream of the water extractor inlet.

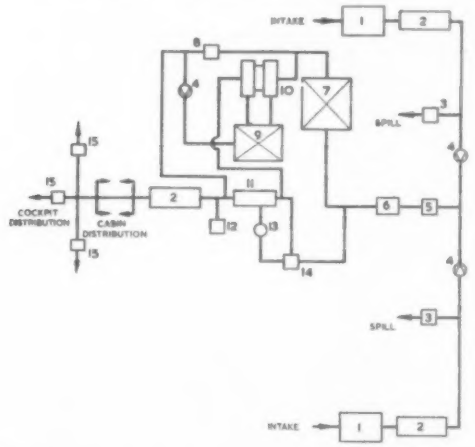


Fig. 3.

1. Superchargers.
2. Silencers.
3. Spill Valves.
4. Non-return Valves.
5. Duct Relief Valve.
6. Choke Heating Valve.
7. Primary Heat exchanger.
8. By-pass Control Valve.
9. Secondary Heat Exchanger.
10. Cold Air Unit.
11. Water Extractor.
12. Ground Connection.
13. Anti-ice Thermostat.
14. Anti-ice Control Valve.
15. Flow Control Valves.

From the primary heat exchanger the air passes through the compressor of the bootstrap cold air unit, then via a secondary heat exchanger to the turbine of the bootstrap cold-air unit, the outlet of which is connected to the water extractor. A by-pass butterfly valve and non-return valve are incorporated in the heat exchanger line downstream of the primary heat exchanger and lead to the secondary heat exchanger which provides temperature control.

The water extractor outlet leads via a silencer to the cabin and cockpit distribution points which are controlled by butterfly valves. For ground cooling and pressure testing a connection is fitted into the main duct system.

Fig. 4 shows a similar system to that of Fig. 3 for the same type of aircraft—that is a twin-engined turboprop but not requiring the degree of cooling. Air for ventilation, heating, cooling and pressurization is provided by two Roots-type superchargers, one on each engine-driven accessory gearbox.

From the superchargers the air passes via silencers, spill valves, and non-return valves to a common duct. The charge air is then fed to a heat exchanger via a duct relief valve, a pressure switch and a choke valve. The flow of ram air to the heat exchanger is controlled by a motorized cooling air valve which in turn is regulated by a temperature control which also regulates the choke valve so that cabin temperatures can be manually pre-set.

After leaving the heat exchanger the charge air passes via a secondary silencer to the cabin distribution points and cockpit conditioning ducts. A ground supply connection is fitted upstream of the heat exchanger to facilitate checking of the pressurization system on the ground and to provide cooling air on the ground.

The system applied to a four-engined turbojet medium-capacity aircraft operating at altitudes up to 36,000 ft. with cabin altitudes not exceeding 8,000 ft., is shown in Fig. 5. The air for this system is tapped from pairs of engines port and starboard, each side being a separate circuit.

The air passes through a shut-off valve on each engine, then into a common duct through a flow control valve, which is

AIRCRAFT SYSTEMS AND SERVICES . . . .

designed to keep a constant flow of air from the engine compressors. From there the duct is split into two; one half is routed through the heat exchanger into the turbine of the cold-air unit, then through a water extractor where the free moisture is extracted, and then into the cabin distribution system. The other half is diverted and connected into the duct downstream of the water extractor.

In this duct is sited the temperature control valve. The cold-air unit is of the turbine fan type where the fan of the cold-air unit is used to draw the ambient air through the heat exchangers for cooling purposes. A recirculation fan is incorporated so that cabin air can be recirculated to increase the rate of change of air in the cabin.

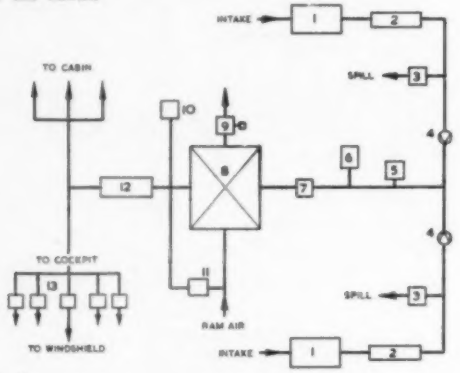
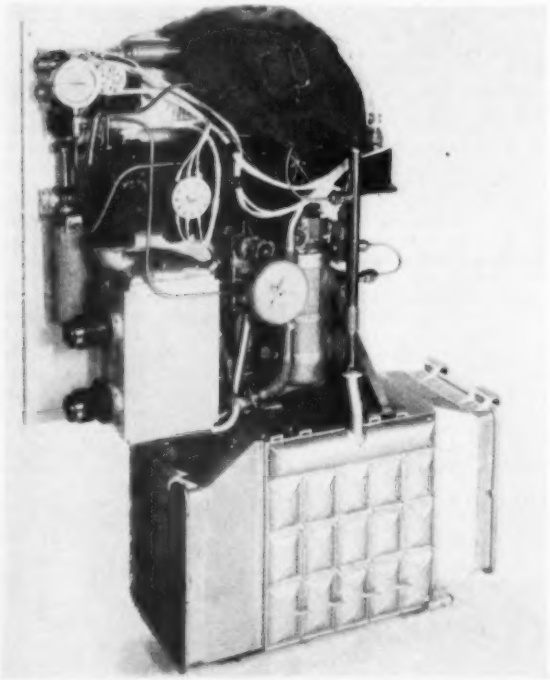


Fig. 4.
1. Superchargers.
2. Primary Silencers.
3. Spill Valves.
4. Non-return Valves.
5. Duct Relief Valve.
6. Pressure Switch.
7. Motorized Choke Valve.
8. Heat Exchanger.
9. Motorized Cooling Air Valve.
10. Ground Connection.
11. Emergency Ventilation Valve.
12. Secondary Silencer.
13. Flow Control Valves.

Fig. 6 shows a system for a twin-engined turboprop aircraft operating at altitudes up to 30,000 ft. with cabin altitudes not exceeding 8,000 ft. This aircraft is of the small-capacity executive type operating over a large range of ambient temperatures. In this case it will be seen that air supplies are available from an independent auxiliary powerplant as well as from cabin superchargers driven by the main engines.

Air for the air-conditioning system of this aircraft is supplied



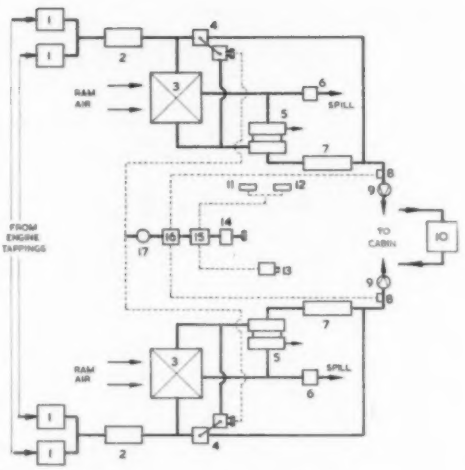


Fig. 5.
1. Shut-off Valves.
2. Flow Control Valves.
3. Heat Exchangers.
4. Temperature Control Valves.
5. Cold Air Unit.
6. Fan By-pass Valves.
7. Water Extractor.
8. Duct Thermostats.
9. Non Return Valves.
10. Recirculation Fan.
11. Air Temperature Sensor.
12. Cabin Sensing Element.
13. Temperature Selector.
14. Temperature Setting Potentiometer.
15. Cabin Temperature Controller.
16. Motorized Selector.
17. Amplifier.

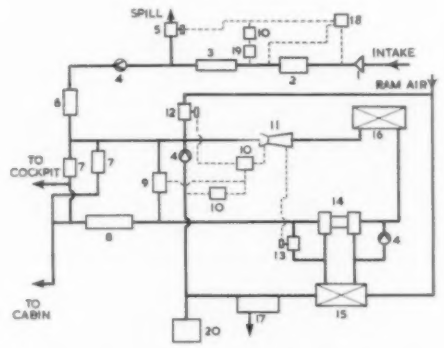


Fig. 6.
1. Filter.
2. Supercharger.
3. Silencer.
4. Non-return Valve.
5. Spill Valve.
6. Choke Heating Valve.
7. Temperature Control Valves.
8. Water Extractor.
9. Anti-ice Valve.
10. Pressure Regulators.
11. Low Flow Sensor.
12. Ram Air Valve.
13. Low Flow By-pass Valve.
14. Cold Air Unit.
15. Secondary Heat Exchanger
16. Primary Heat Exchanger.
17. Ground Cooling Fan.
18. Pressure Sensor.
19. Temperature Sensor.
20. Auxiliary Power Unit.

by a single Roots-type cabin supercharger situated in the starboard engine nacelle and mounted on an accessory gearbox driven by the engine. The air after passing through an air intake filter and supercharger then passes through a silencer, non-return valve and choke heating valves.

It is then initially cooled in a primary heat exchanger, before passing through the compressor side of a cold-air unit of the bootstrap type into the secondary heat exchanger. It then passes through the turbine of the cold-air unit, where further decrease in temperature takes place. After this, the free moisture is extracted in the water extractor before it enters the distribution system.

The temperature control valve is sited in a duct connected downstream of the choke heating valve and after the water extractor. A low flow by-pass valve is fitted across the turbine of the cold-air unit. Ram air is used for cooling of both primary and secondary heat exchangers.

In addition to the primary air supply by the Roots-type cabin supercharger, an auxiliary gas turbine powerplant is carried in the aircraft. From this air can be supplied to the air-conditioning system when the aircraft is on the ground with no main engines running and also in an emergency in flight in the event of malfunctioning in the primary air supply.

A vapour cycle cooling unit specially designed by Sir George Godfrey and Partners for the air-conditioning system of a military aircraft. It is in production for the R.A.F.

MR. J. C. BAMFORD, Chairman and Managing Director of J. C. Bamford (Excavators) Ltd says:

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Cockpit of the de Havilland Dove 8 owned by J. C. Bamford (Excavators) Ltd., showing the Decca Flight Log and Decometers. The installation consists of a Decca Mark 8 Receiver (¼ ATR) and Computor (¼ ATR), Flight Log and Receiver control boxes and display head, the total weight of all units being less than 45 lbs.

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AIRCRAFT SYSTEMS AND SERVICES . . . .

Engine and Aircraft fuel control Systems

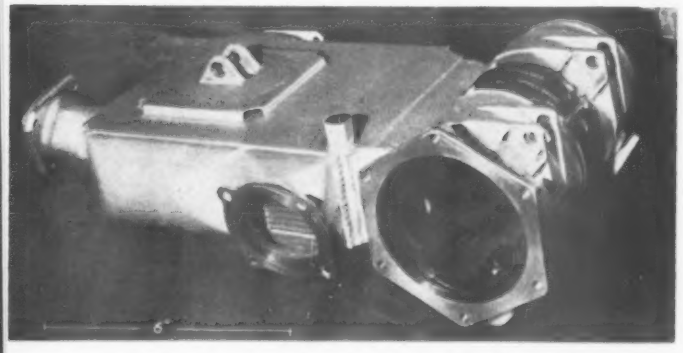
By A. Jubb*, B.A.

THE duty of the engine fuel system is to supply the right quantity of fuel at the right pressures to the engine combustion chambers so as to produce the engine result required by the pilot's controls, as fast as the engine will allow, without exceeding any limitations set by the engine, the engine intake or the combustion system. Engine fuel systems are therefore designed from the fuel injectors backwards to the aircraft tanks.

Fuel injectors may be of many forms, and the choice of injectors is influenced by aircraft and engine requirements such as flow ranges, temperature and starting. These dictate the pump pressure requirements. British practice has been to ease the combustion problem by using smaller jets and higher pump pressures, and this has led to the development of the Lucas variable-stroke piston pump running at up to 2,000 p.s.i., whereas American practice has been to keep pressures down to about 800 p.s.i. and use pressure end-loaded gear pumps such as the Pesco and Chandler-Evans.

Both piston and gear pumps have reached a good standard of reliability. The variable-stroke piston pump has a reduced drive power requirement, less fuel temperature rise at low flows, and improved stability compared with the gear pump and spill valve systems, but none of these advantages is decisive in general.

Considerable thought has been given to the use of the centrifugal pumps, but to date the low pressures available at starting conditions have prevented their use except in special cases, because many conventional types of control are unsuitable for working at this low pressure. In addition, the high-speed gear drives necessary to reduce fuel heating to manageable proportion at altitude are unfavourably viewed. (Direct shaft drive at engine speed results in a pump with large skin friction losses.) In spite of these objections, a case for the centrifugal pump can be made for a light small engine, and one engine has been flown successfully with such a fuel system designed by H. M. Hobson, Ltd.



Two fuel system components by Marston Excelsior Ltd. Above, a stainless steel fuel heater for the Rolls-Royce Conway and (right) a flexible fuel tank for fuselage installation.

Controls

Requirements of the control system may be, as a minimum: (1) Top speed control, to prevent engine overspeed. (2) An idling control, to prevent flame extinction. (3) A throttle lever giving a range of power control. (4) A shut-off cock.

We may also need: (5) An acceleration control. (6) Flame temperature control. (7) A stress limiter control; and a wide variety of special controls for particular duties.

The degree of complication, and the type of control, depend on the engine and aircraft requirements. A low pressure ratio engine working over a limited altitude and forward speed range may be acceptable for many duties without any acceleration control at all. A higher pressure ratio engine working over a large altitude and Mach number range may need a complicated control calibrated to very fine limits, especially if the compressor surge margin of the engine has been reduced to obtain the very maximum of engine performance, and if the aircraft intake under adverse flight conditions produces distorted air inlet velocity profiles to the compressor.

There is therefore no single system which is best for all conditions. The systems are made as simple as possible to give satisfactory performance in the aircraft.

The steady running controls on most British engines have been, almost by tradition, controls of fuel flow. The engine runs at whatever speed it consumes the selected flow. If the control produces the wrong flow, the pilot has to alter the throttle lever to get the speed he wants.

The virtues of such systems are that the controls are generally fairly simple and robust (or were originally conceived as such), and small errors in calibration are not disastrous. Also, partial engine failure due to any mechanical cause allows the engine speed to drop, whereas a constant-speed control would maintain the engine speed by increasing the fuel flow and could cause further rapid engine damage by overheating the turbine blading.

The steady running control is usually compensated for intake air pressure only, and gives only an approximation to engine demand. The effects of day temperatures and differing Mach numbers are neglected, and sufficient fuel is made available to cover the coldest intake temperature at the particular intake pressure. This results in "lost motion" of the pilot's lever on hotter days when maximum engine speed becomes available at lower fuel flows, and the top speed governor comes into operation.

Such a system—the Proportional Full Range Flow Control manufactured by Lucas and used by Bristol Siddeley on Olympus engines—consists of two variable main flow orifices in series, passing the major engine fuel flow, one worked by the pilot's lever and one by the intake pressure via an hydraulic servo, the pressure drop across the two orifices being held to a value which alters with throttle angle by an hydraulic potentiometer. A small subsidiary orifice also passes the idling fuel flow which can be varied as desired at different altitudes.

The pressure drop control setting can be modified by a temperature control solenoid altering the fixed orifice part of the hydraulic potentiometer.

Another Lucas unit, the Proportional Flow Control, takes

* Chief fuel systems engineer, aero-engine division, Rolls-Royce, Ltd.

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a fraction of the engine fuel flow, modified by the throttle angle, and alters the variable-stroke pump outlet until the fraction is a known function of intake pressure. The fraction is obtained by equating the pressure drop across the throttle with the fractional flow pressure drop across two reference orifices by a linking valve. By altering the reference orifices, trimming terms such as temperature control or speed governing can be fed into the system.

This system is used on the Rolls-Royce Avon and Conway civil engines.

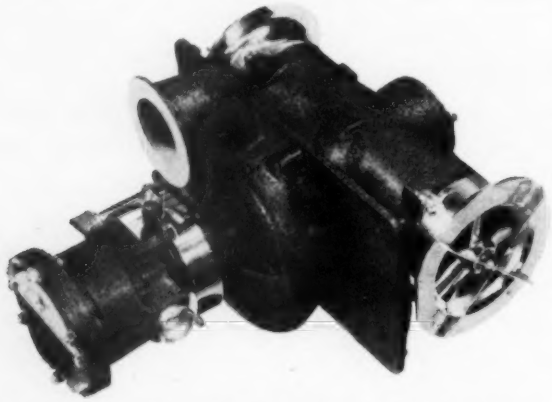
The Dowty single-circuit control used with spill burners on the Gyron Junior engines, employs a fixed displacement piston pump feeding all the fuel to the main swirl entry slots of the spill burners, and controlling the spill back to pump inlet from the atomizer spill ports by a servoed, profiled plunger. This system is unusual in that it is primarily a range speed governor.

Inflow to the spill burners is proportional to engine speed and the pressure drop from input to spill is therefore a measure of engine speed. Comparison of this pressure drop with a spring loaded by the pilot's lever gives a signal of engine speed error, and the spill control plunger is servoed to correct this.

The acceleration controls on all the above systems are based on compressor outlet pressure and pressure ratio in various methods, which vary according to the severity of the demands of accuracy and "shaping" of the engine requirements.

Both the Lucas systems use full compressor outlet pressure, or a variable fraction according to pressure ratio, to position a profiled plunger in an orifice, the pressure drop across which is limited to a constant value by a servo working on the pump stroke. The Dowty single-circuit system again limit-positions the profiled spill plunger in a similar manner, but the relative values of the compressor pressure terms are different because of the effect of the r.p.m. term injected by the fuel pumps.

In all systems the basic components consist of force-balance systems where evacuated capsules, diaphragms and springs, load hinged rocking levers (often with pressure seals at the hinges), and the error position resulting moves a half-ball which obturates the escape flow of fuel from the servo pressure side of a differential area piston. Such systems are obviously somewhat sensitive to dirt or debris but proper proportioning of the hydraulic systems has brought failures due to this down to a negligible level when operated on reasonably clean fuel.



This Lucas hydraulically driven boost pump supplies fuel from the aircraft tanks to the engine's main high-pressure fuel pumps.

Another method is for the rocking lever to operate a shutter which blocks a jet of fuel which normally impinges on a total head orifice (kinetic jet), thus giving a controllable servo pressure. This system is less sensitive to more or less round dirt, but owing to the fact that most hydraulic servos are bouncing to a greater or less degree, the half-ball type of servo will accept substantial amounts of large dirt as long as it is not in the form of slivers, which must be filtered out.

Some design problems of these controls are centred in the components of the lever systems. It is essential that springs, capsules and diaphragms must not change their calibrations even by small amounts. When a diaphragm is subjected regularly to 1,000% overloads and should be consistent to 1%, solutions are difficult. A pressure hinge which will withstand 2,000 p.s.i. and not affect the force balance tends to occupy excessive space. Considerable development has been necessary to meet this type of requirement.

The landed servo valve, as used in many oil servos, has not been favoured in this country after initial experience which showed bad dirt sensitivity and bad corrosion trouble with the hard non-stainless steels used.

Requirements for smaller and lighter units, tailored to fit into a given aircraft and engine shape, have resulted in most of the components being grouped into one or two complete packages. All these systems have a large number of internal passages, and sealing the joints is obviously a problem, rather by the number of the seals than the individual difficulties; the increase of pressures in these systems has given rise to extrusion failures of the rubber seal rings, but development has reduced this to very small proportions.

Top-speed Governors

All these systems use separate governors to limit the top speed of the engine. These have been hydraulic, working by the fuel pressure rise in the radial drillings of the pump rotor acting on a spring-loaded diaphragm and moving the diaphragm to operate a half-ball and orifice system controlling the variable-stroke pump in parallel with the main controls; the half-ball, which opens first, controls the pump.

This simple type of governor suffers from an increase in controlling speed with reduction in fuel flow, if a reasonable stability is to be obtained; but, by using the interaction of the steady running control half-ball or kinetic jet with the governor half-ball, a reasonably satisfactory governor can be produced to work over a good range of altitude. (This interaction of two controls is not restricted to these—the acceleration control, and any other direct control on the pump servo, will cause similar effects which must be assessed and allowed for.)

While such a governor can be quite satisfactory on one fuel for, say, a civil Avon engine in a Comet, following a well-established route, changes of fuel density due to random fuel uplift and changes of temperature could be disastrous for a fighter engine. For this, a hydraulically relayed flyball system has been developed which provides a signal substantially insensitive to fuel density and temperature. It has also been used as a convenient source of r.p.m. signal to operate variable geometry features of the engine such as swirl vanes, etc., using the main engine fuel as the power source.

On the Dowty fuel system the normal range speed governor control is sensitive to fuel density in the burners, and therefore a separate mechanical flyball governor is used acting directly on a spill valve servo.

Low-pressure Systems

The main engine fuel systems require that the fuel shall be supplied to the pumps in a reasonably clean condition and free from vapour and air at a pressure sufficient to suppress cavitation at the engine pump inlet. To ease the low-pressure aircraft system requirements, backing pumps are often fitted and driven by the engine, so that over a considerable altitude the aircraft tank booster pumps can be switched off. Both centrifugal and vane pumps have been used very satisfactorily, and this system shows notable weight savings for civil aircraft where double safety is required, as compared with duplicating tank booster pumps and duplicated electrical busbars.

Engine fuel systems are always fitted with a main flow filter, partly to catch unusual contents of aircraft tanks such as nuts, washers and dead mice, and partly to allow for the occasional heavy contamination of fuel with dirt due to a failure in refuelling cleanliness. It should be clear that no engine-carrier filter should be asked to cope with regularly contaminated fuel, this ought to be done in the ground servicing equipment. One cannot conceive of a system which will work better on dirty fuel, but useful advances have been made in handling the dirt contamination problem.

One form of contamination of the fuel is water, which is always in solution, and is precipitated by cooling of the fuel in flight, notably in aircraft with integral tanks. The water forms crystals of kerosene hydrate which can rapidly block the main fuel filters and any fine filters downstream. This can be catered for by injecting methanol into the sensitive spots when required, or continuously heating all the fuel. (Intermittent fuel heating to de-ice the filter can produce refreezing of the water in a cold control unit with resultant blocking of the small orifices and malfunction of the controls.)

Both systems produce significant weight penalties for long-range operation, but to date no better solutions have been found. Additives freshly mixed with the fuel will work: but their effectiveness diminishes rapidly with storage time of the mixed bulk fuel.

AIRCRAFT SYSTEMS AND SERVICES . . . .

Developing Helicopter Flight Director Techniques

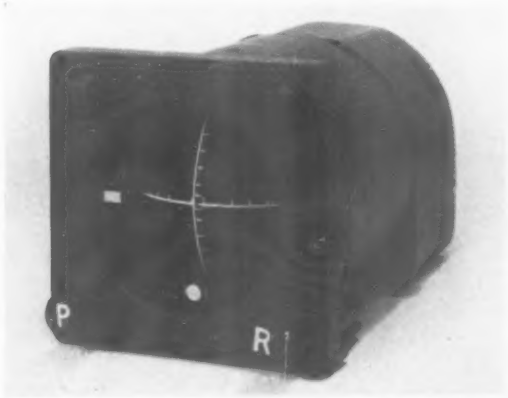
Valuable progress has been made by B.E.A.'s Helicopter Experimental Unit in its work—sponsored by the Ministry of Aviation and aided by the U.K. Sperry company—towards the development of practical flight director equipment and techniques for all-weather helicopter operation

MOST people know that the operational requirements for, and characteristics of, helicopters are such that the straightforward attitude/heading type of flight director as applied to fixed-wing aircraft is of limited practical use. The information required by the pilot of a helicopter—except, perhaps, when cruising—must be almost fundamentally different if accurate control is to be maintained.

In a fixed-wing flight director the present-state-of-flight and correction-demand indications need essentially to be only those of attitude and the demand-indication displacements can be more or less in direct proportion to the error or required change in flight path.

Such information, including that for heading, might be adequate for a helicopter pilot when cruising—though the inherent instability would, without autostabilization aids, require him to work very hard for his living—but is inadequate for low-speed flight and, in particular, during the approach. In these conditions attitude indications cease to relate to the flight path and attitude-correction demands must include those for collective pitch and associated power adjustments.

The work of B.E.A.'s Helicopter Experimental Unit, sponsored by the Ministry of Aviation, might be considered as a practical, operational extension of that being done by the Royal Aircraft Establishment at Farnborough and Bedford. An engineering team from the Sperry Gyroscope Company in the U.K. has been assisting B.E.A. with the development of equipment; considerable experience has been gained by Sperry in America on such flight director programmes.



Modified Sperry Zero Reader with the conventional cross-pointer demand indicators, but with, on its left, collective-pitch director pointer and below, a yaw (tail-rotor pedal) director index. In the B.E.A. presentation the collective-pitch director is a separately mounted Smiths P.V.D. "barber's pole" unit which provides compelling demand information.

The practical work has now gone far enough for an operational specification to be written. The existing system, in one of B.E.A.'s Westland S-55s, is experimental and necessarily made up of a number of variously obtained components capable of doing their share of the total job. It has, nevertheless, served to demonstrate the practicability of the overall concept.

The requirements were for a system which, using preset heading, speed and height information, offered instrumentation which would give normal fore-and-aft and heading demand indications related to a helicopter's characteristics and to its control reactions at different speeds; and which would provide easily followed collective-pitch/power demands to hold an accurate flight path on the approach.

The familiar cross-pointer Zero Reader is at present used as the primary instrument. This provides the conventional demand indications, but the inputs are related to control displacement as well as to gyro, heading, speed, height and ILS (or other) signals, which are suitably mixed in computers.

A Smiths P.V.D. "barber's pole" unit is used for collective-pitch direction. The vertical movement of the helix is "followed" by the pilot with the lever, the movement of which is, as in all helicopters, mechanically interconnected with the throttle control to give some basic measure of automatic power to match the collective-pitch changes.

Earlier proposals included a yaw director, but a total of four instruments presented obvious difficulties and the information (apart from that normally obtainable from the slip indicator) is required only during the last stages of an approach—when the pilot will have reverted to visual flight. Attention to two instruments—for heading/attitude and collective pitch—is hard work, but during cruising flight and the first part of a descent it will be a two-axis task and collective-pitch control does not become vital or critical except during the limited later period in the approach.

A demonstration flight from Gatwick showed that, using preset heading, height and speed data, manual instrument flying, at least with autostabilization, has been made into a reasonable task. Commercial helicopters of the future will have fully automatic control and a flight director system is likely to be a primary aid only in smaller helicopters for which a limited instrument-flying capability will be adequate. Its principal value will be as an emergency reserve and as a monitoring system for the fully equipped helicopters. Meanwhile the B.E.A./Sperry system can be considered as an essential step towards operationally practical automatic control and as a valuable aid in the development of control requirements and presentation methods for more complex and essentially fail-safe systems.

A more complete presentation would include, in addition to the four-axes director displays, information about the aircraft's attitude, using, in this version, roller-blind techniques. The pitch and roll director demands are integrated in the intersection "dot" index.

The U.S.A.F. Looks Ahead

ALTHOUGH at first sight the schemes illustrated on this page may seem more reminiscent of science fiction than practical engineering, they are being taken seriously enough in the United States. They constitute, in fact, part of a "forward look" which the U.S.A.F. is taking at the space-vehicles which may be expected to stem from the development of giant rocket boosters exceeding 1,000,000-lb. thrust levels.

In support of these design investigations, the Martin Company has recently been awarded a $140,000 contract by the Wright Air Development Division of the Air Research and Development Command. Similar contracts have also been arranged with Convair, Douglas, General Electric, Lockheed and Norair.

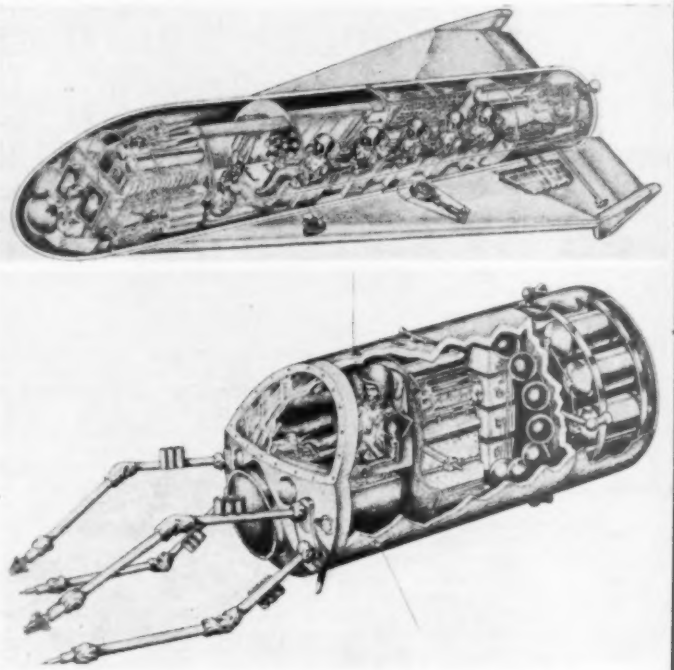
Aim of the project, which goes under the name of SLOMAR (short for Space Logistics, Maintenance and Rescue) is to outline proposals for spacecraft capable of (a) engaging in servicing and rescue operations; (b) the assembly in orbit of prefabricated space-vehicle sections; and (c) the ferrying of men and supplies to and from space-stations orbiting the Earth. The Martin Company has already spent a year on preliminary studies.

The programme looks forward over the next 15 years with the object of devising vehicle systems which have maximum reliability and safety and yet incorporate features of maximum economy providing for the earliest practical utilization. It involves problems of orbital mechanics, human environment studies, navigational and radar systems, vehicle homing and lock-on systems, space transfer sub-systems, maintenance techniques, solar radiation studies, propulsion devices for stabilization and navigational control, and escape techniques for the crew.

The one-man "space tug" would be used for assembling a large space-station in orbit. Martin's design is based on the assumption that men individually clad in space-suits will not have sufficient mobility and tools. This space-tug would, therefore, be equipped with power tools and remotely controlled manipulators similar to those at present in use in the field of nuclear energy. The vehicle would contain a computer, an autopilot to prevent tumbling, a rocket motor for manœuvring, and air and food supplies adequate to sustain the operator for up to 48 hours.

Total vehicle weight would be about 8,000 lb. It is a sobering thought that the latest Soviet "satellite-spaceships" already exceed 14,000 lb.

The second scheme is proposed as a ferry vehicle for carrying five men, or an equivalent payload, between the Earth and a space-station. It, too, incorporates rocket motors for performing necessary orbital manœuvres. After the mission, the vehicle would return to Earth as a hypersonic glider after the fashion of the Dyna-Soar, from which its designers would hope to derive considerable experience.



With other companies, Martin's Denver Division has a U.S.A.F. contract for studies of advanced spacecraft systems. Top, Martin concept of the SLOMAR five-man ferry vehicle. Below, SLOMAR "space-tug" from the Martin project study. Complete with operator, it would weigh about 8,000 lb.

The Martin Company is, of course, already prime contractor for the booster portion of the Dyna-Soar project, which involves the two-stage Titan II. The company is also participating in NASA's manned spacecraft project, Apollo, and in RIFT (Reactor In-Flight Test); the latter is expected to involve the Saturn booster with a top stage employing a Rover nuclear reactor.

New Weather Satellite

A NASA contract worth about $4.5m. is being negotiated with the General Electric Company's Missile and Space Vehicle Department for the construction of the first two Nimbus meteorological satellites. The project is being managed by the Goddard Space Flight Center.

Nimbus is the second project in NASA's long-range research and development programme to explore the problems and technology of global weather analysis. The first extensive meteorological satellite programme, Tiros, has already produced more than 35,000 pictures of the Earth's cloud cover and much new radiation data.

The new satellite will differ from Tiros in two major respects. First, it will be orientated so that the TV cameras will look down at the Earth at all times; and second, it will be launched into a polar orbit, permitting the cameras to photograph the entire globe during each 24-hr. period. A Thor-Agena B two-stage booster has been selected to launch the first Nimbus satellite from the Pacific Missile range in 1962 into a 600-mile altitude circular orbit.

With a total weight of approximately 650 lb., Nimbus will contain as many as six TV cameras which are improved models of those used so successfully in Tiros. A number of infra-red sensors, similar but also superior to those embodied in Tiros II, will be carried in addition.

Two large "paddles" of solar cells will convert the Sun's energy into electrical power to operate the satellite's instrumentation; these will also serve to re-charge chemical storage batteries for continued operation during periods of darkness. Other essential components will be tape-recorders, and telemetering and command equipment. A thermostat will maintain the vehicle's internal temperature at about normal room temperature at all times.

Cloud pictures and other data stored in the satellite will be played back on command from the primary-acquisition station at Fairbanks, Alaska. All data obtained will be analysed by meteorologists of the U.S. Weather Bureau and the defense establishment. Foreign scientists will be invited to participate in the meteorological aspects of the programme.

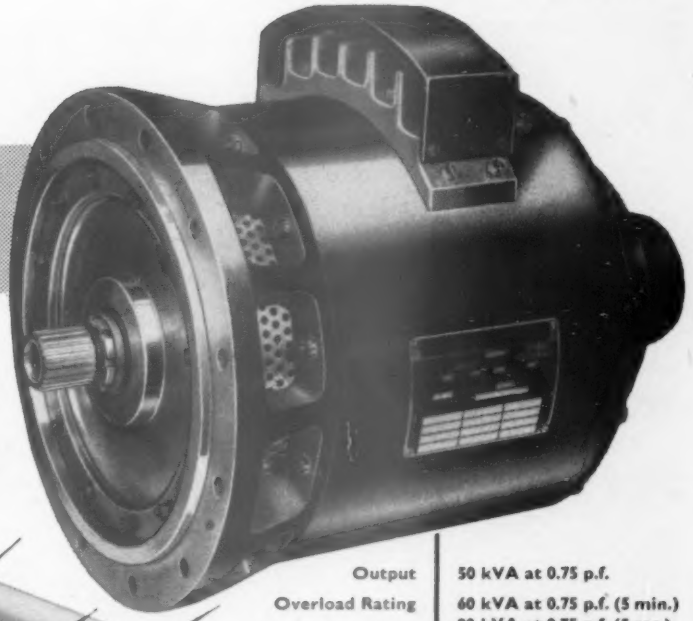
Saturn Contract

WITH the first flight-weight prototype of the 1.5m. lb.s.t. Saturn booster nearing completion at the Marshall Space Flight Center in Huntsville, Alabama, NASA is negotiating contracts with three companies for the supply of first-stage 70-in.-dia. tanks for five Saturn vehicles. The companies are Boeing Airplane Co., Chance-Vought Corpn., and the Martin Co. They were among 18 firms which submitted proposals for the contract which is worth about $2.25m.

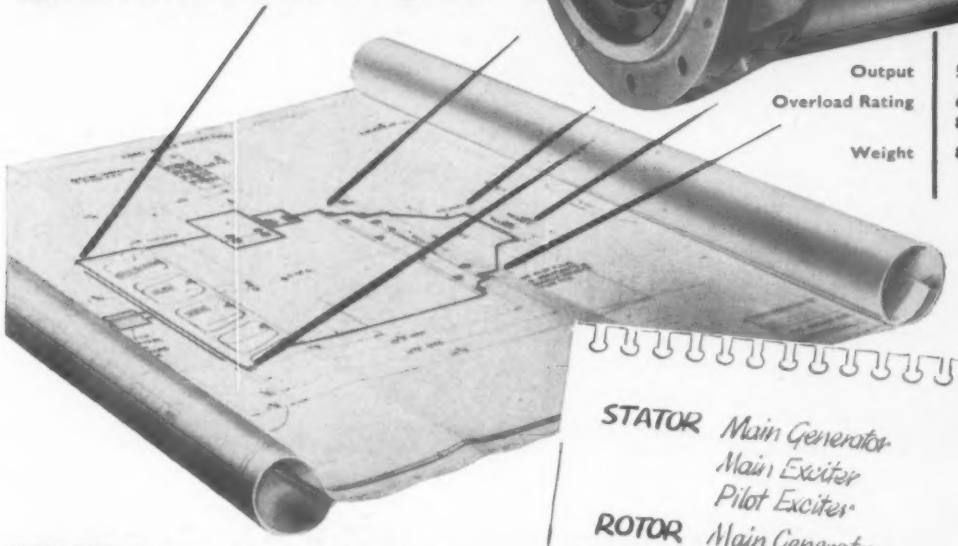
Delivery is to begin in mid-1962. Assembly of the 22-ft.-dia. S-1 stage will continue at the George C. Marshall Space Flight Center. Each stage contains nine tanks, one 105-in.-dia. liquid oxygen tank being located in the centre of a cluster of eight 70-in.-dia. tanks, half of which contain RP-1 (kerosene-type fuel) and the other half liquid oxygen.

The contract calls for production of 40 70-in. tanks required for the five boosters, plus two spares. Selection of the final contractor will be made by Dr. Wernher von Braun, director of the Marshall Space Flight Center.

50 kVA A.C. BRUSHLESS GENERATOR



Output	50 kVA at 0.75 p.f.
Overload Rating	60 kVA at 0.75 p.f. (5 min.) 80 kVA at 0.75 p.f. (5 sec.)
Weight	87 lb



		lbs. ozs.
STATOR	Main Generator	19 - 4
	Main Exciter	7 - 7
	Pilot Exciter	2 - 4
ROTOR	Main Generator	18 - 2
	Main Exciter	8 - 2
	Pilot Exciter	4 - 4
	Shaft and Bearings	14 - 0
	Frame, End plates and Terminal Blocks	13 - 9
	TOTAL	87 lbs

1960 50 kVA A.C. brushless air-cooled and oil-cooled generators with static control gear in quantity production for civil and military aircraft.

1958 First rotating rectifier type brushless A.C. generators designed and manufactured in this country for main generating systems in aircraft, on test in 'ENGLISH ELECTRIC' Bradford Laboratories.

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THE **ENGLISH ELECTRIC** COMPANY LIMITED,
AIRCRAFT EQUIPMENT DIVISION, PHOENIX WORKS, BRADFORD

AE.52

The crew of a Sea Vixen prepare for take-off as a Buccaneer passes overhead.

Fly as an officer in the ROYAL NAVY

Today the aircraft carriers are the capital ships of the Fleet, and the most advanced jet aircraft are in squadron service in the Fleet Air Arm.

Flying superb aircraft such as the Sea Vixen and the Scimitar (and soon the Buccaneer) is a hand-picked team of officers who are among the most highly skilled pilots and observers in the world.

Training as a Naval Officer in the Fleet Air Arm includes a six months course at the Britannia Royal Naval College, Dartmouth. You must possess above average intelligence, resourcefulness and character, and have a spirit of adventure controlled by a strong sense of responsibility.

If you have a zest for flying and are attracted by the Naval way of life, you will find that the task of the Naval Officer in the Fleet Air Arm is exciting, exacting and singularly rewarding.

The age limits for the Fleet Air Arm are 17—25. You must have a G.C.E. or equivalent with passes at the Ordinary level in English language, Mathematics and three other approved subjects. The Admiralty will however be prepared to consider boys with four Ordinary levels only, if they are otherwise exceptionally suitable candidates. Applicants under the old regulations will continue to be accepted until 1st September, 1961. A high standard of physical fitness is necessary.

When qualified, pay at age 20 is £949 a year: a married officer of 25 can receive up to £1,760 a year. After 12 years' service there is a tax-free gratuity of £4,000. Selected officers serving on a 12-year engagement may have the opportunity of transferring to a pensionable career.

Special 5-year commissions for Helicopter Pilots only

There is a new scheme of engagement for men wishing to specialise as helicopter pilots. They join between ages 17—26 on a 5-year commission and receive £775 tax-free gratuity on termination.

Send for the new illustrated booklet which will give you full details.

The Admiralty, D.N.R. (Officers), Dept. AP/21, Queen Anne's Mansions, London, S.W.1.

FAA.15

Probing the Ionosphere

LATEST of NASA's current crop of scientific satellites is the 74-lb. ionosphere beacon S-45. Its launching from Cape Canaveral in the nose of a three-stage Juno II rocket was scheduled last week. Object of the exercise is to discover more about the shape of the ionosphere—where, for example, there are concentrations of electrons, and where the ionosphere's profile has peaks or valleys in its structure.

The ionosphere is, of course, the ionized zone in the upper atmosphere, ranging upwards from 50 to several hundred miles, which is used for the reflection of radio waves. The zone is often adversely affected by sun spots and solar disturbances which cause breakdowns in radio communication. In consequence, there is an urgent need to obtain more information, not only in so far as this affects the improvement of long-range communications, but by virtue of the fresh light which such investigations may throw on the influence which disturbances in the ionosphere have on the Earth's weather.

Of particular interest is that New Zealand's Seagrove Radio Station is participating in the S-45 experiment as well as American universities. Under the direction of Dr. J. E. Theridge, the Seagrove station—which is part of the University of Auckland—was expecting to conduct a study of the bearing and elevation of antipodal signals from the satellite.

Experiments of this kind have more than academic interest for New Zealand. Radio communication between Europe and the remote dominion is unfortunately only too often beset with radio signal interference. Because setting up several stations in Europe to study signals from New Zealand would be very expensive, the scientists concerned appear to have found a possible solution in a co-operative venture with NASA. A satellite which crosses Europe repeatedly at different points, they stress, can provide this much-needed information.

The satellite itself closely resembles Explorers VII and VIII in having a shell formed of two truncated cones placed back to back. The S-45, however, has a 6-ft. loop antenna around its equator for the purpose of transmitting low-frequency signals to ground stations.

Unlike Explorer VIII, the satellite will not be an experiment in itself. Whereas Explorer measured the positive ion and electron concentrations in its orbital path, the new satellite will merely transmit on six frequencies at varying levels of power. Ground stations will analyse the signals received by various methods such as change in polarization or Doppler shift.

The satellite was expected to orbit the Earth every 116 minutes with an apogee of about 1,600 miles and a perigee of about 240 miles.

Another ionospheric satellite of interest is the S-27 Topside Sounder which is being developed, in co-operation with NASA, by the Defence Research Telecommunications Establishment of Canada.

An Adventuring Mind

AT the Northampton College of Advanced Technology on Jan. 19, a large invited audience, mainly from the aircraft industry, heard Prof. Dimitri Riabouchinsky, D.Sc., the distinguished scientist of *L'Academie des Sciences de l'Institut de France*, speak on "Some Special Problems in Fluid Mechanics."

Although much of Prof. Riabouchinsky's lecture concerned theoretical and mathematical aspects of his life-study in gas dynamics and hydrodynamics, his reminiscences on some early practical applications of his work were of general interest. As a result of "a considerable private fortune," the speaker had established a small but well-equipped laboratory in Russia in the early 1900s. It was here that his experiments in fluid mechanics began, and in 1912 he was able to open a hydrodynamics laboratory.

Rocket research engaged his attention during the First World War when he worked on "the resistance of pointed projectiles" and "the reaction of gaseous jets." Among his inventions, Prof. Riabouchinsky showed a photograph taken in July, 1916, of a Russian soldier with a recoilless "bazooka-type" rocket gun. Another proposed application was a rocket-powered harpoon. There was also a diagram of a jet-powered "flying-disc" which the lecturer said he had constructed in 1924.

But the main thread of his researches—in Russia and France—has always been the basic theory behind the motion of gases and liquids and the special problems associated with bodies immersed in them. Aviation and astronautics owe much to the patience and dedication of such pioneer scientists. As one speaker put it at the end of Prof. Riabouchinsky's lecture, his are "the exacting adventures of an enquiring mind."

"How Far is Up?"

A NEW principle of international law was established when satellites were sent into space by various nations during the I.G.Y. No permission was sought by any nation, none was given and no protests were made about the launchings. Such lack of action proves the new principle, Mr. Paul G. Dembling, general counsel to the National Aeronautics and Space Administration, recently told the American Rocket Society meeting in Washington, D.C.

He said no action has yet been taken to define territorial rights in space, but no legal authority believes that territorial rights should apply to space, not even in Russia.

The main question to be answered is: where does airspace end and outer space begin?

Three types of proposals have been made:

(1) Geophysical limit, which would set the troposphere, the ionosphere or similar division, as the limit.

(2) Air-breathing limit, above which aircraft requiring atmosphere cannot fly.

(3) Arbitrary limit, set at a certain altitude.

Mr. Dembling said that the law must consider socio-economic as well as the physical problems of spaceflight.

The legal principles regarding liability for damage from space vehicles of any kind are quite well set already, he said. Responsibility for damage, direct or indirect, would fall on the launching nation. Indirect damage from radioactivity would be included under this classification.

Concerning commercial exploitation of space, an entirely new legal field will be opened, Mr. Dembling said. If commercial firms can launch their own satellites, licensing laws must be made. The rates they can charge for their services must be considered. Provisions for national and international control of such use of space must be established.

Another approach to this vital subject has been conducted in a two-year study by the American Bar Foundation. This reveals there is too much integration of military and non-military uses of outer space. One problem, says this report, is how to find a workable formula to separate the military from non-military applications.

The problem is complicated by world tensions reflected in the East-West power struggle and concern for national security. The inability of the U.N. Committee on Peaceful Uses of Outer Space to define "peaceful uses" is an illustration of the problem, says the report which was prepared under a grant by the National Aeronautics and Space Administration.

The report is a comprehensive outline of the broad range of space activities; the related problems of regulation and control that make it necessary to determine "how far is up," or the air limits of national sovereignty; and the liability involved if a rocket or parts of it launched by one nation fall on the territory of another. The rocket debris that recently landed in Cuba from Cape Canaveral illustrated these difficulties.

The U-2 incident is an example of the problems involved in the question of "how far is up." The aerial reconnaissance of the U-2 was challenged as a violation of national sovereignty, but there was no objection to the two American satellites orbited about the same time. The satellites were TIROS, a forerunner of a reconnaissance satellite with photographic ability, and an early MIDAS, a warning satellite designed to respond to the heat from missile launchings.

Do the differences in altitude and in vehicles make the activity politically and legally acceptable to states whose territories are observed? What are the boundaries of outer space? Do any, in fact, exist? These questions are basic to any international agreement or law on space. However, the position of any altitude line drawn varies with virtually every legal opinion.

Nevertheless, it appears possible to regulate or extend the present limits of international agreement on the use of radio wavelengths for communication purposes. This may be done, the report suggests, by merely amending and adjusting present laws and regulations.

The use of space for weather forecasting ultimately may involve the problem of weather control, in which all nations have a vital interest. With advances in space technology and increasing space traffic will come the need for international safety standards, which is, in itself, a vast problem.

Manned space travel will involve such problems as the repossession of space craft and the repatriation of astronauts who may land in a foreign country.

Executive Aircraft Operation

Apache Across the Atlantic

Long-range flights by light aircraft have now become a common and convenient means of delivery, particularly across the Atlantic. In this article,* SARAH FLOWER *discusses some of the procedures involved on such a trip.

NOWADAYS, light aircraft cross the Atlantic with little fuss or notoriety. They are mostly American machines on delivery flights to European purchasers, but despite the latest equipment and modern navigational provision for the trans-atlantic journey, any sea crossing of over 1,000 miles can be a hazardous business to the inexperienced pilot.

Captain Peter Nock, a full-time ferry pilot who handles deliveries for R. K. Dundas, made a late November crossing last year in a Piper Apache. This flight, with good or average weather for the time of year, serves as a fair example to illustrate the technical and navigational processes involved.

The 1958 Apache, purchased from the States for delivery to Switzerland, flew under an American C. of A. and was on the American register. Before transatlantic flight was possible it was necessary to fit two 70-gal. tanks internally and add an HF set to the normal quota of Apache radio. To cover these additional installations a ferry permit had to be obtained from the FAA. This permit was valid for 30 days, since the weather over the North Atlantic at that stage of the winter may keep a light aircraft land-bound for days on end.

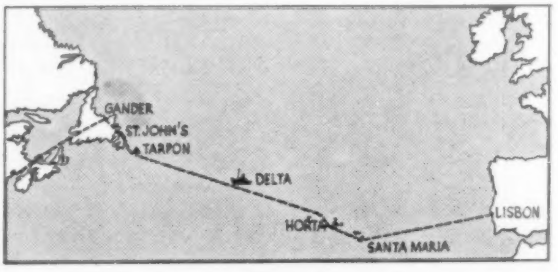
Gander, the great jumping-off point from Newfoundland (and an enormous, luxurious terminal centred in wasteland), was reached after some delay: it had been necessary to wait for weather conditions to improve to 800 ft. and two miles visibility in light snow. This was followed by another 24-hr. delay at Gander; departure was impossible the next day due to large amounts of cloud with icing conditions immediately east of the airport. A Constellation arriving from Europe had experienced this weather and been forced down through weight of ice. The Apache had no de-icing and this constituted its most serious weather problem. Accordingly, consultations on prevailing weather conditions were held with a number of arriving crews.

There are three alternative routes for transatlantic flights from Gander. The Arctic route, which is Gander-Keflavik-Prestwick; the longest all-sea route, which is Gander-Shannon; or Gander-Azores-Lisbon-London. Both the first two routes are uncertain in winter and on this occasion there was a chronic depression centered over the northern part of the Atlantic, causing strong headwinds on its northern side, Gander-Keflavik, and particular icing hazards on its southern side, the Gander-Shannon route.

Thus the Gander-Azores route was chosen and a full day later, after getting fairly good reports from an R.C.A.F. crew in from the Azores and optimism from the Met., a dawn start was considered possible. A K.L.M. crew, met over a pre-dawn breakfast, radioed back that there were no icing conditions to worry about on the ascent. Ten minutes later the Apache took-off from Gander at a maximum all-up weight of 4,200 lb. This was approximately 10% over normal and licensed by the ferry permit. The rate of climb was correspondingly slow, but although the temperature was slightly below freezing, no ice was formed in passing through a thin layer of cloud from 2-4,000 ft.

The first leg of the flight was from Gander to Torbay range. Cruising altitude of 9,000 ft. was reached shortly before Torbay. Torbay is the range station of St. John's, the most easterly point of the American continent, with a jagged, snowridden coastline. The second leg, of 110 miles, was straight down the south-east leg of the Torbay range to reporting point Tarpon. By maintaining the range leg it was easy to check the drift against the estimated drift on the forecast wind. Canadian Defence Radar were called and requested to give a series of positions in order to check the groundspeed. Unfortunately, Radar were unable to pass these positions, giving the possible reason that the Apache was too small to keep on their screen. Without knowing the groundspeed it was, of course, impossible to find a wind; but the drift on the range leg being the same as the estimated drift tended to show that the Met. wind was accurate.

The third track was a rhumb line from Tarpon direct to Santa Maria, Azores, divided into sections of 5° of longitude to allow for changes in the track heading, the variation and



the forecast winds. This track was to pass approximately 50 miles south of the weather ship, Ocean Station Delta. In order not to risk falling south of track and thereby failing to establish contact with the "Delta," the Apache turned on to its new heading three minutes before the E.T.A. for Tarpon.

VHF contact was now lost with Torbay and all communications with oceanic control continued on HF with 5611.5, the best frequency. Approximately 50 minutes before estimating abeam the weather ship the Apache started calling them on VHF, initially with no contact. About the same time the ADF picked up the beacon on "Delta," and with a 30° left deflection showed the aircraft to be passing south of the weather ship as expected.

About 15 minutes before abeam the weather ship, VHF contact was established and shortly after this the ship passed a position as a bearing and distance from itself. As Ocean Station Delta was not itself "on station," and VHF communication was not very clear, it was not immediately possible to establish the ship's position. However, when passing abeam a running fix was taken on a series of bearings on the ADF: these checked accurately with the radar position passed by the weather ship and showed the Apache's position slightly north (perhaps 10 miles), of track and some 70 miles south of the weather ship.

Ground speed check showed the average westerly winds were not quite so strong as forecast, the aircraft being 10 minutes

SPRINGBOARD.—Useful jumping off point for many Atlantic crossings, Gander was so used by the Apache in the accompanying story.

behind estimate. Twenty minutes after passing Ocean Station Delta, VHF contact was again lost and the radio compass became gradually weaker. At about this time the Apache was forced to climb to 13,000 ft. to avoid fairly extensive cumulus build-ups.

For the next hour and a half, no positive checks on the navigation were possible without a sextant. Estimated positions were regularly passed to oceanic control on HF, but when at last the Flores beacon was picked up, it showed a considerable deflection to the right. As Flores was still a long way off and the track passed virtually over that island, it was somewhat alarming to appear so far north of track.

The Apache continued, however, without altering course, to get a steady reading on the Flores beacon, and a reasonable cut on the Horta beacon. Position was then established as some 50 miles north of track and some 15 minutes ahead of E.T.A. This was undoubtedly caused by the stronger WSW wind at 13,000 ft., which had been averaging around 50 kts. for the previous two hours. From this fix, course was altered for Horta, and after homing to this beacon, course was set again for Santa Maria.

The short winter's day had passed, and by the time Horta was overflown it was completely dark. A couple of cu-nims were stacked over the Pico volcano and these were just avoided in the last rays of a brilliant sunset. The remaining hour to Santa Maria presented no problems navigation-wise, with the help of Terceira beacon and VOR, and the Santa Maria range. The weather on this last part was very stormy with heavy rain but, after 15 minutes holding over Santa Maria, because of the departure of one aircraft, the Apache touched down at Santa Maria exactly 10 hours to the minute from take-off.

The transatlantic flight to Lisbon was very straightforward in good weather, with the initial outbound track down the Santa Maria range leg to reporting point "Delta." After that, it was possible to get good fixes with the aid of the Lugo CONSUL Station, Seville and Casablanca beacon. Five hours after take-off, Lisbon NDB was coming in strength five, on the nose, and a VMC landfall completed another flight.

Not quite complete, perhaps, as a very co-operative Lisbon A.T.C. gave the Apache permission to land into a strong wind on the short runway which was being re-surfaced. Admittedly they pointed out that there were rollers and other equipment on the top half of the runway, but they did not mention that the right half of the runway was some six inches higher than the left. . . . However, no damage was done and, as the pilot will agree, almost any kind of a landing on land is preferable to one in the Atlantic.

Personal Flying

The Seaplane Club came into official being on Jan. 20, at Londonderry House, when, during a second meeting of aero-marine enthusiasts, the feasibility of such an organization was unanimously agreed. Following the report of the committee, headed by J. Lankester Parker as chairman, which was elected at the initial meeting, it had been decided that the most desirable location for club operations was on the Medway, opposite Gillingham, with Lee-on-Solent as second choice.

The committee also recommended the renting of a new Piper Super Cub 150, a similar aircraft from the Cessna range, or possibly a Piper Colt on floats. The Cub would cost £5 an hour to rent, plus fuel, oil and daily servicing, which would bring the cost to members to about £7 an hour. A guaranteed utilization of at least 300 hr. per annum was required, which would necessitate a yearly income of £2,100. About £500 initial capital expenditure was also necessary for equipment, including a motor-boat, and one full-time employee at £6-700 a year.

To meet these costs, it was necessary to guarantee a minimum of 75 flying members, with a subscription of 12 guineas a year, plus non-flying members at five guineas a year. Flying charges would be £7 an hour, dual or solo. Initial subscriptions of 10s. were also suggested, to cover administrative expenses of club formation, and the full subs. would be required when the club was ready to accept delivery of its seaplane. Those who have expressed interest or who desire to become members of the Seaplane Club are invited to send 10s. subscription to Air Cdre. G. J. C. Paul at the Royal Aero Club.

• • •

Latest report on the Rallye claims a total of 166 confirmed orders for this Morane-Saulnier three-seater, 85 being from 17 different foreign countries. The U.S. agent, Mr. Coleman, reports a total of 22 orders, with deposits, and even at the planned production rate of one aircraft per day, from July, 1961, deliveries from new orders cannot be achieved until 1962.

To speed production rates, Morane-Saulnier has decided not to consider any request for modifications in the Rallye.

• • •

Piper production is planned to increase from an average of 8½ aircraft per day to 12½, by Mar. 1. This higher rate is scheduled for the main Lock Haven plant, which will be augmented by the new Vero Beach plant, now getting into production with the new all-metal low-wing Cherokee. By summer, this year, production of five Cherokees per day is expected.

At Lock Haven are produced the Apache and Aztec light twins, the Comanche, the Super Cub, the Pawnee and the new Piper Colt. Public interest in the Colt has exceeded expectations and is largely responsible for the increased production by Piper. Two Colts have been ordered for early spring by the Denham Aero Club. The first Pawnee agricultural aeroplane has now reached this country, at Kidlington, where a C. of A. for it is awaited by Vigors Aviation, U.K. Piper dealers.

• • •

Following the success of the Rent-a-Plane scheme for the long-term hire of Piper Cubs and Caribbeans by flying clubs, another American light aeroplane is now available on a similar basis. This is the two-seat all-metal Aircoupe which is being handled in Europe by Air-Rent, Ltd., from Stapleford Airfield, Essex.

KAYE AT KIDLINGTON. — A recent visitor to Kidlington, where Wg. Cdr. Tim Vigors (right) holds the Piper distributorship, was comedian Danny Kaye who is himself a private pilot. He has about 400 hours' flying experience to date, and flew the Aztec light twin during his visit to Kidlington.

Aircoupe rental is a simple form of contract hire for a minimum guaranteed utilization at a flat rate. The operator is responsible for hangarage, daily maintenance and fuel; all other costs, including capital outlay, maintenance to full Public Transport standards, insurance and depreciation, remaining the responsibility of Air-Rent. For a guaranteed minimum of 300 hr. per annum, the rental is only £3 5s. an hour, falling to £3 for 400 hr. annual utilization, and £2 15s. thereafter.

For a further 5s. an hour, the basic aircraft is available with a 12-channel VHF radio, incorporating VOR.

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A repair, overhaul and installation service, for aircraft radio and navigational aid equipment, has been established at Luton by McAlpine Aviation, the business flying division of Sir Robert McAlpine and Sons, Ltd. Specialist services are being provided for owners or operators of such types as the Piaggio P.166, the Cessna and Piper ranges, Aero Commander, D.H. Dove and Heron and Dakota.

The Air Radio department is housed in a new hangar and headquarters being built for McAlpine Aviation at Luton Airport.

• • •

Air Cdre. H. Probyn, R.A.F. (Retd.) has been doing some more flying in Kenya in his Volkswagen-powered Grunau Baby, which we described in our issue of Jan. 6. He recently completed an 800-mile return trip from Nyeri to Malindi, on the East African coast, during a week-end, and also had a very turbulent flight to Kitale, 170 miles away, and back.

He has now flown some 86 hr. in the Grunau in its powered form, but finds this 45 ft. span ultra-light really hard work to control in the midday bumps. He was recently awarded a gilt trophy by the American magazine *Sports Illustrated* following an article on the conversion of his glider.

(*Gliding Notes page 190*)

Industry Record

Transport Command Contracts

Elliott-Automation, Ltd., has received initial orders valued at £500,000, for lightweight 21 Series VOR/ILS navigation and VHF communications equipment for Transport Command. The equipment, which will be manufactured by the Airborne Radio and Radar Division of Elliott Brothers (London), Ltd., is identical with the 21 Series supplied to a number of other NATO air forces.

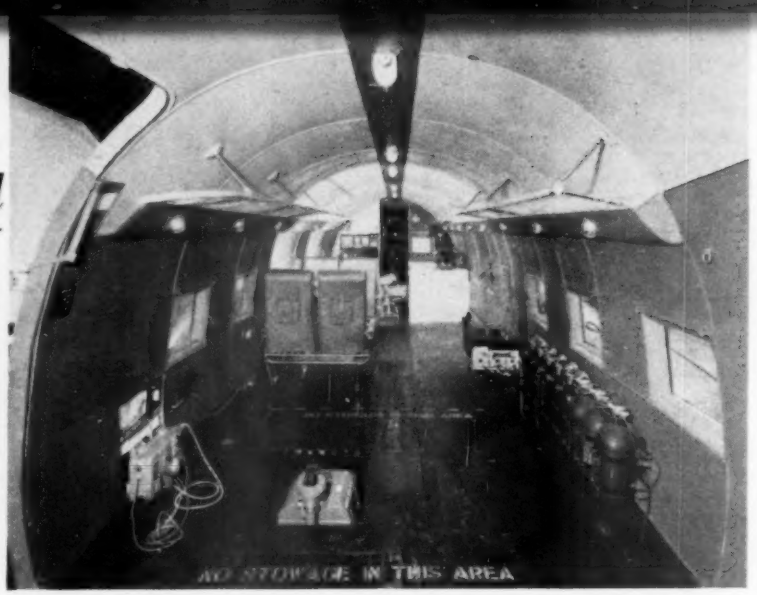
The contracts are the first major orders for this equipment for the Services in this country. It is to be installed in Transport Command's Argosies, Belfasts and Comet 4s.

Dakota Conversion

Modifications to a Sudan Airways Dakota completed recently at Airwork Services, Ltd., Hurn base will enable the aircraft to undertake survey and mapping duties during a tour of operations with the Sudan Government Survey Department. These duties will be in connection with geological and archaeological research, irrigation, forestry and soil investigation.

The variety of equipment with which the aircraft has been fitted includes Decca Doppler, a CL2 gyro-compass, an air mileage unit, air and ground position indicators, navigation sight and statoscope. A Wild RC8 camera is positioned at the tail end of the cabin. Also in the cabin is a combined console and chart table giving both survey and navigational instrumentation, while a special radio console provides AD7092D ADF, STR9Z VHF, AD107/114 HF and AD401 intercom.

To cope with the electrical requirements of the additional equipment, the battery capacity has been increased and this permits self-starting of the powerplants at remote landing strips. An aircrew oxygen system allows the aircraft to operate at 18,000 ft.



The main cabin of the converted Sudan Airways Dakota showing the Wild RC8 camera and controls in the left foreground and a line of oxygen bottles on the right.

Provision has been made for the accommodation of four observers in addition to the standard crew of five.

G.E.C. Activities

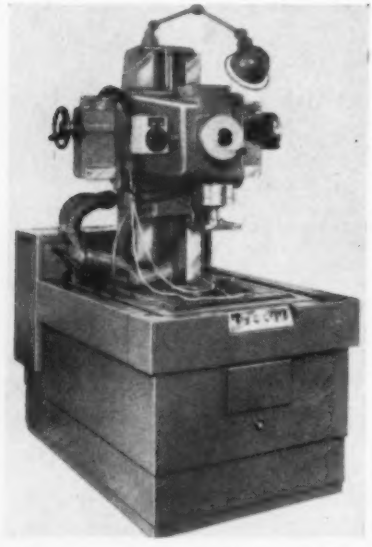
In a review of 1960, the General Electric Co. announces that its aircraft electrical equipment has now been supplied to 107 airlines, air forces and air transport organizations, including Aeroflot and 12 U.S. operators. Contracts placed during 1960 for galley installations include equipment for B.O.A.C. Boeing 707s, B.E.A. Vanguards and Comet 4Bs, S.A.S. DC-8s, B.K.S. Avro 748s and Caravelles owned by Air France, Alitalia, Finnair, S.A.S., Varig, Swissair and United Airlines.

Following tests by the R.A.F. Institute of Aviation Medicine, the company's hot beverage container and a 21-meal hot-cupboard have been approved for use in Coastal Command Shackletons. For R.C.A.F. Grumman Albatross search and rescue amphibians, G.E.C. has developed a compact six-meal air-circulation oven.

The Vickers Vanguard entering service on B.E.A. and T.C.A. routes, has a specially developed G.E.C. fluorescent cabin lighting system in which about half the tubes are operated by 28-volt DC transistor inverters from the batteries and the remainder by 115-volt, 400-cycle control gear from the aircraft supply. The company is also developing a fluorescent cabin lighting system for B.O.A.C. VC 10s and the Avro 748s ordered by Skyways.

The most important G.E.C. development on the airport lighting side last year was the introduction of a new type of visual glide-path indicator unit. Four of these have been installed on runway 24 at Southend Airport and others have been ordered for Luton, for the R.C.A.F. and for Mauritius. During the year, the company completed airfield lighting schemes at Guernsey, Luton, Leeds/Bradford, Coventry, Wellington (N.Z.) and Nandi (Fiji).

Spark Erosion Machining



The most advanced unit in the Solar Weld Languepin range of spark erosion equipment is this Seleromat B machine which provides "jig-boring" facilities.

A new Anglo-French company, Solar Weld Languepin, Ltd., has been formed to market the Languepin range of spark erosion machines in the United Kingdom and the Commonwealth. Established at the Fulledge Works of Burnley Aircraft Products, Ltd., the company may also manufacture this French-designed equipment in Burnley if the demand is great enough.

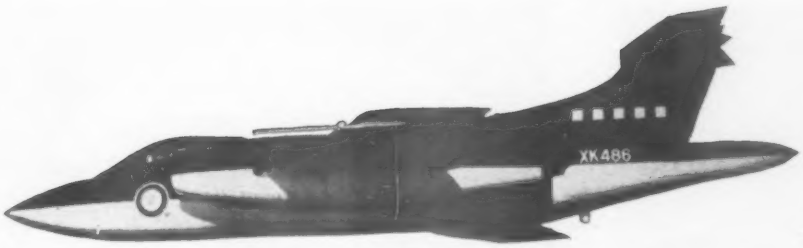
Particularly suitable for machining materials which are difficult or impossible to work by other methods, the Languepin equipment is designed as an addition to, and not a replacement for, the conventional forms of tool making. There are three machines—Seleromat A and B, and Seleromic—in the range and a complete installation comprises the machine itself, a spark generator which is housed in a separate cabinet, and a filtration unit for removing micro-solids from the dielectric fluid.

The Seleromat A has a welded steel base which houses a 100-gal. dielectric tank and its pump mechanism, and incorporates the supports for the work table. The tank completely surrounds the 20 in. × 25 in. machine table and is raised and lowered electrically; this means that the necessity to fill and empty the tank as an integral part of each erosion operation is eliminated.

The electrode carrier and its servo head comprises an integral unit mounted on an articulated arm which swings horizontally and moves vertically on a pillar at the rear of the machine. Servo head motion is derived from a DC motor driving a leadscrew through a reduction gearbox; manual control is provided by two push buttons. Automatic downfeed is governed by electric trips and the depth required can be pre-set on a micrometer scale to increments of 0.001 in.

With a similar base and dielectric tank system to the A model, the Seleromat B has "jig-boring" facilities for the positioning of the electrode over the workpiece. The electrode carrier and servo head unit is the same as for the first model.

Both Seleromat models have four work settings from "roughing" to "super-finish" which provide erosion rates of 1,000, 140, 9 and 2 cu. mm./min. The surface finish varies from 50 microns for the fastest setting down to two microns for super-finish, and the tolerances are 0.004 in. and 0.0003 in. respectively. Mechanical flushing away of debris is achieved by the explosive effect of the spark discharge, by vibration of the electrode, and by high-pressure feeding of the dielectric fluid through the electrode.

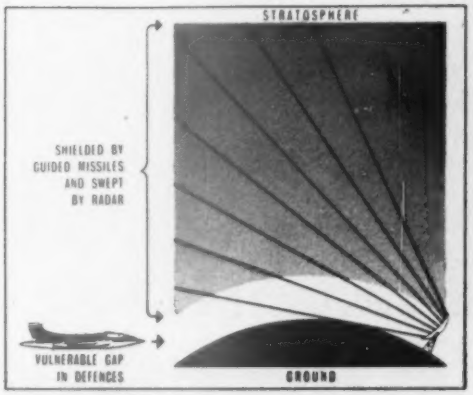


Buccaneer navigation

The pilot's view during a low-level attack

The pilot's simultaneous low-level problems of navigating and of avoiding obstacles in his flight path are automatically solved for him by electronic means.

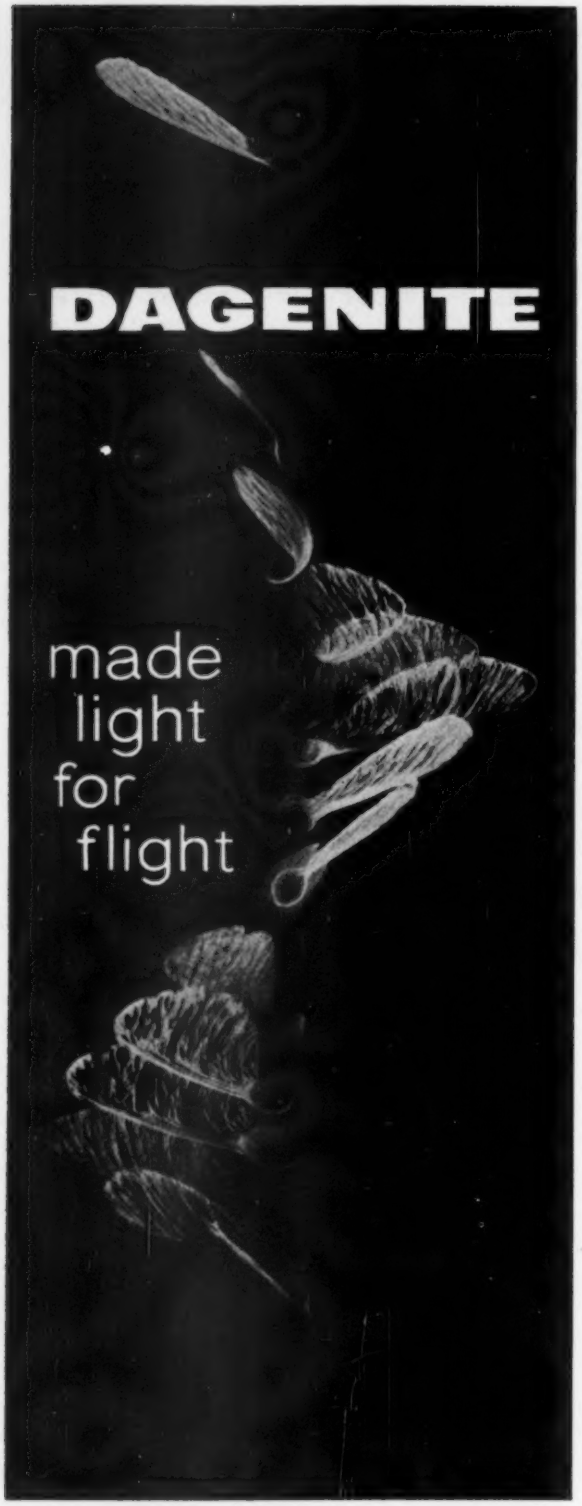
The Buccaneer is electronically an extremely sophisticated aircraft and incorporates the results of very advanced thinking.



Blackburn

BLACKBURN AIRCRAFT LIMITED, BROUGH, YORKSHIRE, ENGLAND

Member Company of the Hawker Siddeley Group



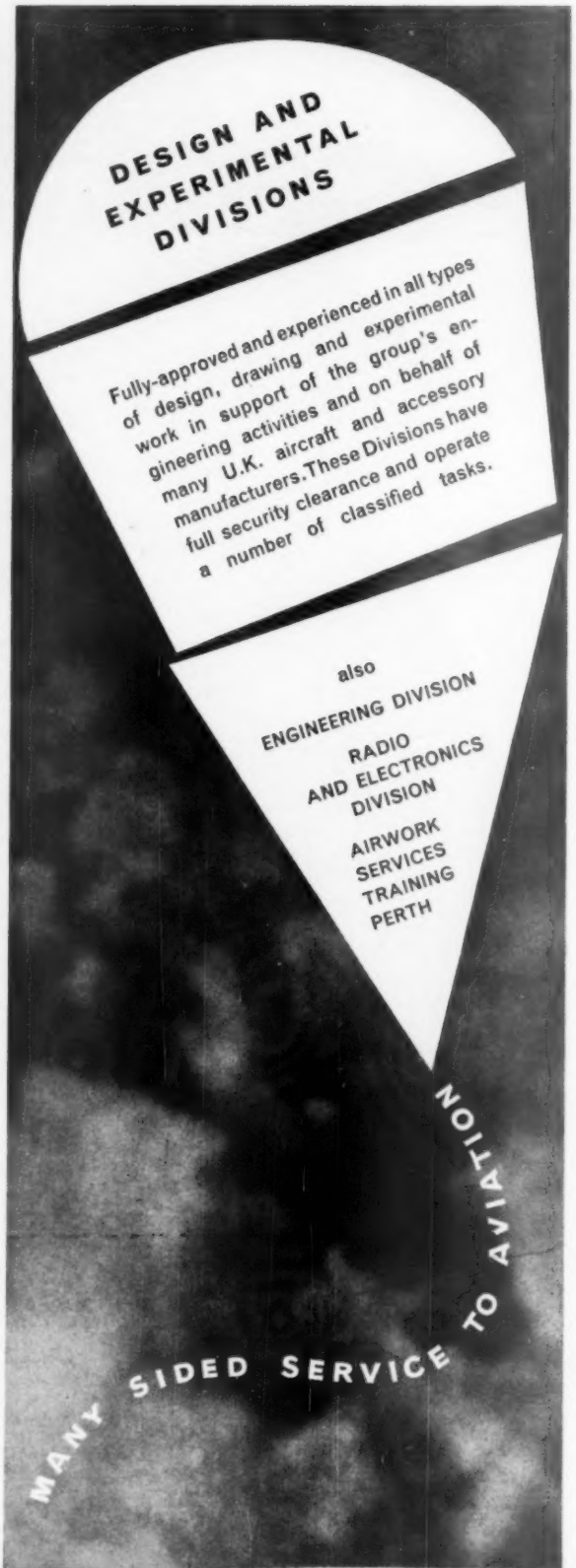
PG47

DAGENITE

AIRCRAFT BATTERIES

Pritchett & Gold and E.P.S. Company Ltd, Dagenite Works, Dagenham Dock, Essex
DOMinion 0121

London Airport Sales and Service Depot: Building 203D, Eastern Perimeter Rd.
Skyport 4321 Ext 6023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Correspondence

Stoutly Said

I WAS delighted to see the letter from Mr. A. F. Bonnalie (Jan. 27) about W. B. Stout's autobiography "So Away I Went!" and the origin of that famous saying, so beloved of our great C. G. Grey "Simplicate and add more lightness."

Two slogans which, I believe, may fairly be attributed to Bill Stout himself are:

"An airplane should be able to support itself financially in the air" and "Don't invent rubber gloves for leaking fountain pens."

I remember speaking to Bill Stout at the River Rouge plant of the Ford Motor Company about the end of 1945. I told him how popular those trick sayings of his were in Great Britain. Could he produce any more for me to take home?

He said: "What you don't put into an airplane don't give no trouble!"

There was a chap—his name is on the tip of my tongue—who wrote . . . "Aviation is the Coming Thing." Not very good I thought. As Horace my tame Stressman used to say: "You don't have to be crazy in this business—but it helps."

Itchenor, Chichester. W. S. SHACKLETON.

Radar at Rome

REGARDING your observation in THE AEROPLANE AND ASTRONAUTICS issue of Feb. 3 that Fiumicino airport has no functioning radar, the fact is the approach radar for Fiumicino functions from Ciampino and can provide full approach radar for Fiumicino.

The radar controllers are being trained by one of the Southern Centre's controllers on loan to the Italian government.

Richmond, Surrey. W. BLOTT.

Spins and Spin Recovery

I AM doing some research into the history of flying training and I would be grateful if you, or any of your readers, could answer the following:—

(a) Who is credited with being the first pilot to discover the original method of recovery from a spin, i.e., centralization of controls? Also approximate date, place and type of aircraft.

(b) From what date, approximately, was stalling and spin recovery introduced into the R.F.C. and R.N.A.S. training syllabus?

(c) Were Maurice Farmans (both Longhorn and Shorthorn) ever deliberately spun and recovered? Or, alternatively, recovered from an accidental full spin?

Ashbourne, Derbyshire. L. F. HENSTOCK.

R. R. Smith-Barry

I AM preparing a short biography on Robert Smith-Barry, the founder of the Gosport system of flying-instruction, and would be grateful for any anecdotes about him that your readers might care to send me.

The Savage Club, London, S.W.1. F. D. TREDREY.

T.A.A. Helicopter Service

MY attention has been drawn to a photograph which appeared in THE AEROPLANE AND ASTRONAUTICS for Jan. 20 (p. 62), bearing a caption which referred to T.A.A.'s "Helicab" as a Bell 47 helicopter. (Another letter about this was published on Feb. 3, p. 130.)

So as to avoid any confusion, it may be worthwhile noting that the helicopter shown is a Hiller Model 12C powered by a Franklin engine. This particular aircraft was originally owned by T.A.A., but was disposed of last year when we purchased two Hiller 12E Lycoming-engined machines. The helicopter in question is at present on charter to T.A.A. and carries our markings, as your photograph shows.

Melbourne, Australia. J. L. WATKINS, (Director of Engineering, T.A.A.)

Shanty Town Blues

YOUR several references to the primitive conditions of London Airport North were echoed by a well-known American film star who rose very early, a few days ago, to go with me to the airport to meet a passenger flying B.O.A.C. from New York and due to arrive at 8.30 a.m. Knowing that tail-wind conditions prevailed, we got there threequarters of an hour before E.T.A. That this precaution appeared to be justified was shown by the arrival, 70 minutes early, of a foreign

Wroundabout

Quel Damage. My old friend Jacques Lecarme, test pilot and engineer with the French company SFERMA, is entranced by a thesis in the Journal of the British Interplanetary Society. It's about landing space vehicles on the moon and earns the writer Wren's Commendation (Irrefutable Conclusions Divn.) for such statements as "Generally, rocks will resist penetration by bodies impacting at velocities ranging from a few hundred feet per second to a few thousand feet per second" and "Under impact loading, various materials behave quite differently" and "The impact . . . of a vehicle against rock . . . can lead to failure of both vehicle and rock"—probably, I should say, in that order. I like the use of "failure"—I once had a flying model dive straight in from about 100 feet. It failed. Utterly.

*

Le Rève Passe. Jacques goes on to say: "That reminds me of a good old joke. In 1928 a French team succeeded in landing automatically a biplane, with a lot of tricks and gyros and vanes and so on. The pilot's answer to a Press correspondent's question was 'At long last, one can transport air passengers without endangering pilots.'"

*

Line Shot

Fighter pilot, talking about a pilot friend in Transport Command: "He's got more hours on finals than I've got in my log-book."

*

Thereby hangs—an ear. Mess games can embroil civilians as well as Service officers. A Civil Servant friend, now in exalted office, recalls the Martlesham Heath Games of 1930 where, he, as jockey, with a certain R.A.F. officer as horse, clashed in the "Horses and Jockeys" game with a formidable Royal Marines weapon system which ground them into the carpet with a lot of sideslip. "On recovery I saw to my horror that my partner's ear was practically detached. With the lightning reaction which life in this Mess taught all of us, I clapped the ear back in place, someone tied on an improvised bandage and the M.O., always obliging on these occasions, did some swift stitching. Hospital surgery finished the job but I never played 'Horses and Jockeys' again. Nor, I think, did he."

*

No Flattern for Slattern. A Spanish journal speaks of the "Presidente della B.O.A.C. Sir Matthew Slattern." Prettn slovenln tnpesetting, nes?

*

P.R.O. on telephone to newspaper: "Beverleys are in the Congo flying in tents." Voice at the other end: "Small turning circle?"

*

"Haven't you got something a little less advanced?"

by Wren

airliner, following a similar route from New York. But the B.O.A.C. plane did not arrive until 1.45 p.m. owing to "mechanical trouble."

When our passenger eventually emerged through the Customs into the public "lounge" the process had taken him so long that we were unable even to buy him a drink! I am a professional journalist and because our visitor had no time to make the cross-country trip to Airport Central, I had to interview him over a cup of expensive, weak coffee balanced on a strip of counter; the few settees and rickety tables available were crammed to overflowing. There was, of couse, the restaurant, but there they were serving only lunches. I had had mine during the interminable wait and the passenger had had his en route.

The comments of both the passenger, an executive of a large Midlands engineering group who had been to the U.S.A. on an export expedition (in accordance with the Government's demands), and of the American film notability were that, in a considerable experience of airport facilities throughout the world, those of L.A.P. hit an entirely new "low."

My own views, though descriptive, are unprintable.

London, S.W.18. C. P. READ.

Publication Received

Alone Across the Atlantic was published last week. The 40-day adventure of its author, Francis Chichester, in winning the first single-handed Transatlantic yacht race in July last year is described in a breezy diary form which reflects the personality of this navigator-aviator-yachtsman. Francis Chichester has been accustomed to making long journeys alone: in 1929 flew solo to Australia and later made the first East-West solo flight from New Zealand to Australia across the Tasman Sea. He also made the World's first long-distance solo seaplane flight, New Zealand to Japan, in 1931. 191 pp., 5¼ in. by 8¼ in. Illustrated. George Allen and Unwin. Price 21s.

Gliding Notes

by Dr. A. E. Slater

AN annual event in London is a meeting of the Central Council of Physical Recreation held to introduce gliding to the young generation, with talks, films, model demonstrations, and one or two full-sized sailplanes parked on the floor. This year's audience of about 150, mainly from schools and various youth organizations, far outnumbered the gliding people present, and the girls among them were encouraged by Wally Kahn's assurance that "a thermal doesn't know the difference between a man and a woman."

Derek Piggott, in addition to his usual demonstrations, such as launching soap bubbles into a thermal rising from an electric heater, brought along a new gimmick, a toy electric winch which launched a model glider halfway to the ceiling. Ann Welch showed a lot of slides and described gliding as "a way of life," and Philip Wills gave an account of Dick Georgeson's new international gain-of-height record flight in New Zealand.

This is not, of course, the C.C.P.R.'s only activity in support of gliding, for it sponsors many of the instruction camps held by clubs all over the country. This year it is organizing a series of all-day visits to gliding clubs by parties of girls.

* * *

THREE Spanish gliding schools have a limited number of places for foreigners this year, and those who want to attend must first send certain documents to the British Gliding Association for forwarding. Monflorite School, near the Pyrenees, trains pupils for "C" and Silver "C" certificates; Llanes, in Asturias, trains for the "B" and "C"; and Somosierra, north of Madrid, trains beginners to "B" stage.

Austria also has three gliding schools open to foreigners, at Zell am See, Aigen im Ennstal, and Spitzerberg. In this case it is best to apply direct to the school, and to do so at least a month beforehand, to give time to deal with the necessary documents.

* * *

LASHAM GLIDING SOCIETY has appointed a new general manager. He is John Cochrane and, unlike the previous three occupants of the post, he comes from the gliding world. After starting with the Cambridge University Club, he went to Bristol, where he took a leading part in securing the Bristol Club's site at Nympsfield, and has been the club's chairman for many years.

* * *

DICK GEORGESON'S World record for gain of height has been beaten within three weeks by a Polish pilot, Stanislaw Jozefczak, flying a Mucha 100a. Georgeson's climb in a New Zealand wave on Dec. 16 was 34,300 ft. (10,455 m.), and he reached an absolute altitude of 35,700 ft. Jozefczak flew on Jan. 4, and his gain of height is given in *Avia-Vliegwereld* as 10,900 m. (35,761 ft.) and his absolute altitude as 12,600 m. (41,339 ft.), which is not far short of the World's single-seater height record of 42,100 ft. set up by W. S. Ivans in California just over 10 years ago.

However, in the Polish paper *Skrzydlata Polska* for Jan. 29 there is an article by Josefczak on his flight, stating that the gain of height has been officially confirmed as 10,674 m., which is 35,019 ft. It looks as if this cannot be recognized as a World record because it does not exceed Georgeson's figure by the necessary 3%, because 3% on 34,300 ft. makes 35,329 ft.

Jozefczak's flight was made in a wave near Nowy Targ, north of the Tatra mountains, which divide Poland from Czechoslovakia and are an offshoot from the northern end of the Carpathians. The highest summit is at 8,737 ft., and is near the eastern end of an east-west ridge about 30 miles long, most of which exceeds 6,000 ft. The famous "Moazagotl" site, where the World's first wave flights were made in 1933, is 210 miles away to the W.N.W.

The weather chart for Jan. 4 shows rather light southerly winds at the surface. An approaching cold front has almost come to a stop just to the west of the site, but the inversion at its frontal surface would slope away to westward. As to the wave being helped by an anticyclonic inversion, the nearest high-pressure centre was off the map beyond the Urals.

The barograph record shows a steep but irregular climb to 16,000 ft., followed by a drop to 8,000 ft., then, after recovery, a smooth climb which slowed down considerably for the topmost 3,000 ft. but remained smooth.

Aviation Calendar

Feb. 20

Coventry.—Lanchester College of Technology. Rocket Engine Technology lecture, "Design of Liquid Propellent Rocket Engines," by D. H. Bradney, in the College, at 19.00 hrs.

Feb. 21

London.—R.Ae.S. lecture, "Newer Metallic Materials of Construction," by Dr. N. P. Inglis, in the Lecture Theatre, 4 Hamilton Place, W.1, at 19.00 hrs.

New York.—International Airline Navigators Council 11th Annual Convention, at the Hotel Manhattan; until Feb. 23.

Feb. 22

Hatfield.—R.Ae.S. Branch lecture, "Space Research," by Prof. H. S. N. Massey, in the de Havilland Restaurant, at 18.15 hrs.

Feb. 23

London.—Aerodrome Owners Association, A.G.M. at 15.00 hrs. and Dinner at 19.00 hrs. at the Hyde Park Hotel, S.W.1.

Feb. 27

Coventry.—Lanchester College of Technology. Rocket Engine Technology lecture, "Rocket Engine Testing," by A. W. Broomfield, in the College, at 19.00 hrs.

Mar. 1

Hull.—R.Ae.S. Brough Branch lecture, "Aircraft Production Techniques," by A. R. Courtman, in the Royal Station Hotel, at 19.30 hrs.

London.—R.Ae.S. Graduates and Students Section A.G.M., in the Lecture Theatre, 4 Hamilton Place, W.1, at 19.30 hrs.

London.—Kronfeld Club, opening of the Photographic Competition, in the Basement, 74 Eccleston Square, S.W.1.

Company Notices

NEW COMPANIES

AIRLEC, LTD. (681,486).—Private co. Reg. Jan. 24. Cap. £1,500 in £1 shs. (300 "A" ordinary and 1,200 "B" ordinary). To design and undertake research development work in connection with aeroplanes, guided missiles, rockets, etc. Directors: Jonathan F. Sherhod, 10 Oaken Park, Codsall, Staffs; Terence H. Stanway, 19 York Gardens, Wolverhampton; Derek B. Evershed.

AVIATION AND GENERAL CATERING SERVICES, LTD. (681,306).—Private co. Reg. Jan. 23. Cap. £100 in £1 shs. Sec.: R. Baksh.

TUDOR AVIATION, LTD. (681,886).—Private co. Reg. Jan. 27. Cap. £2,000 in £1 shs. Aerial spraying of all kinds, crop and general spraying contractors. Directors: Richard H. Tudor (permanent managing director), Eston House, Vaughan Avenue, Grimsby; Noel W. Barnes, 18 Seacroft Road, Cleethorpes. Sec.: D. S. Garrs. Reg. off.: 39 Hainton Avenue, Grimsby.

INCREASE OF CAPITAL

Vickers-Armstrongs (Aircraft), Ltd. (650,323), Vickers House, Broadway, S.W.1. Increased on Jne. 16, 1960, by £7,999,900 in £1 ordinary shs. beyond the reg. cap. of £100.

New Patent

APPLICATION ACCEPTED

864,212.—**Costruzioni Aeronautiche Giovanni Agusta.** —"Helicopters." May 13, 1959. (Mar. 27, 1959.)

Printed specifications of the above will be available on Mar. 29, 1961, and the opposition period will expire on Jne. 29, 1961.

Personal Notices

BIRTHS

Balfour.—On Feb. 1, at 22 Rosemead, R.A.F. Halton, to Judith (*née* Anderson), wife of Sqn. Ldr. A. J. C. Balfour—a daughter.

Flinn.—On Jan. 31, at Redruth Hospital, Cornwall, to Jane (*née* Lambert), wife of Flt. Lt. P. Flinn—a daughter.

Rosser.—On Jan 28, at the Duke of York Home, Bradford, to Denise (*née* Ellse), wife of Flt. Lt. W. J. Rosser—a son.

Watson.—On Feb. 3, at Crowborough Hospital, Sussex, to Jennifer, wife of Flg. Off. G. Watson—a son.

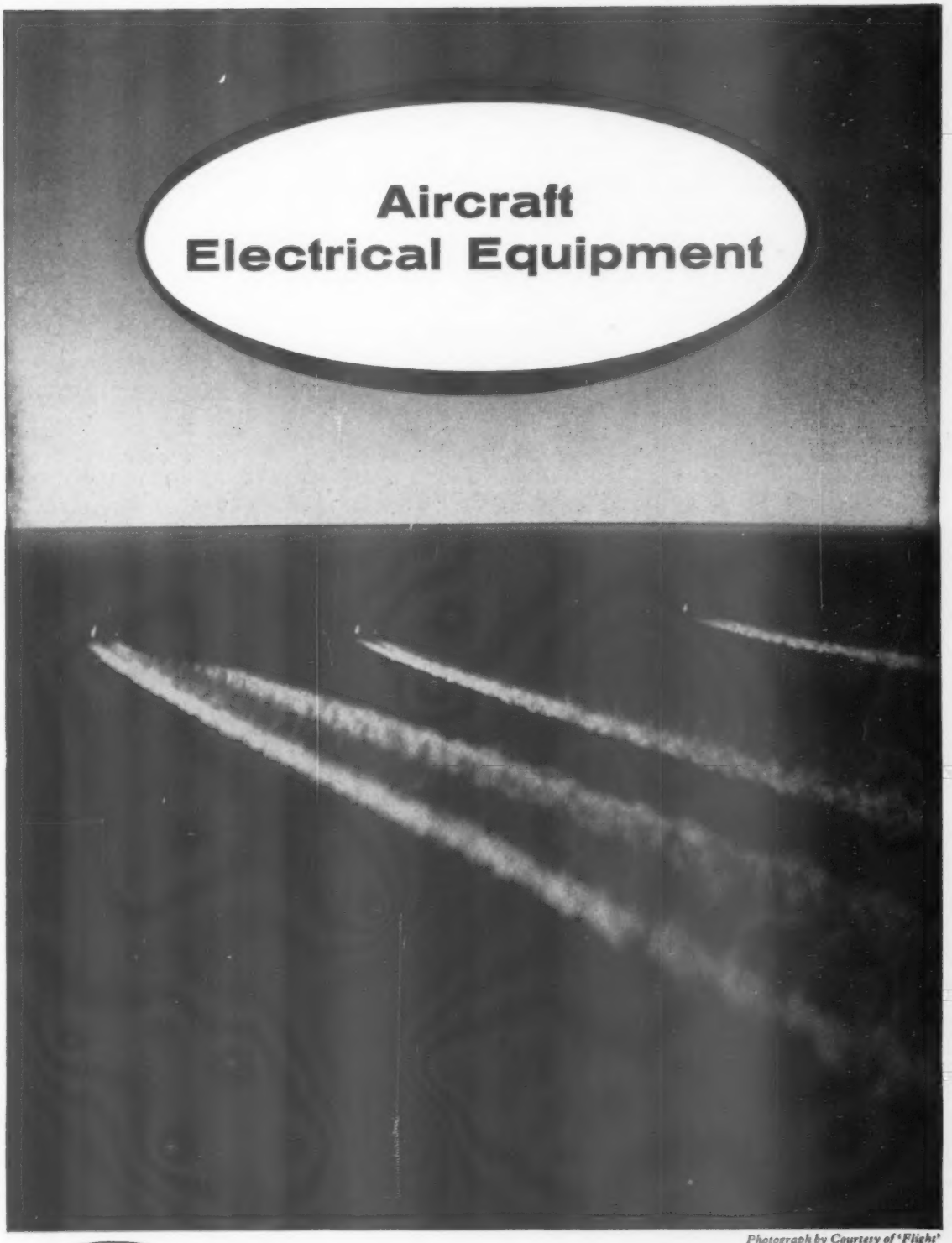
DEATHS

Collins.—On Feb. 2, Wg. Cdr. H. B. Collins, at St. Helier, Jersey, aged 59.

Gilchrist.—On Feb. 2, Sqn. Ldr. Samuel (Jock) Gilchrist, M.B.E., at the Royal Sussex County Hospital, Brighton.

Grant.—On Feb. 3, Air Cdre. George William Patrick Grant, C.B.E., at Ashford Hospital, Kent, aged 49.

Aircraft Electrical Equipment



Photograph by Courtesy of 'Flight'

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Engine hours are particularly good with only 30 since complete overhaul. It carries long range tank and full radio aids.
Spar modifications allow for 15,000 hours on the wings and 10,000 on the centre-section.
It has a current C. of A. expiring in May of this year.
Listed below is the radio equipment installed:
VHF: STR.12D, STR9X and Collins 17L8 Transmitter (90 channel).
VOR: Collins 51X3 Receiver (190 channel) Localizer 344D1.
ADF: Marconi AD.7092.
ILS: Standard SR14/15 incl. Fan Marker.
MF/HF: Marconi Receiver only.

LIGHT AIRCRAFT DIVISION

CESSNA 172. REF. 3190.

We have available for immediate sale a 1959 Cessna 172, with only 380 airframe hours since new. It is a very well maintained aircraft with many extras, including wheel spats, etc. It carries a good radio station, including 90-channel VHF, Narco Mk.2 incorporating VOR and ILS, and ADF. It has a three year C. of A. expiring in March 1963.

META-SOKOL

Another of the interesting overseas aircraft confirmed for exhibition and demonstration at the Shackleton Aviation Weekend at Coventry.

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PIPER TRI-PACER. REF. 3098.

An excellent Tri-Pacer ready for immediate sale. 800 hours since new: 160 h.p. engine with only 58 hours since complete overhaul. It carries a three year C. of A. until December 1963. It also carries Narco Super Homer LFR3 and is finished in blue and white.

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Internally it is equipped as a 12 seater and finished in grey leather. The duplicated Decca system allows for flight log in the forward cabin as well as the cockpit, and the engines are equipped with Sperry analysers.
The aircraft carries full airline radio aids, full deicing, auto pilot, etc. and is offered now with a twelve months C. of A. and Check 2 carried out. It can be inspected at Gatwick by appointment.

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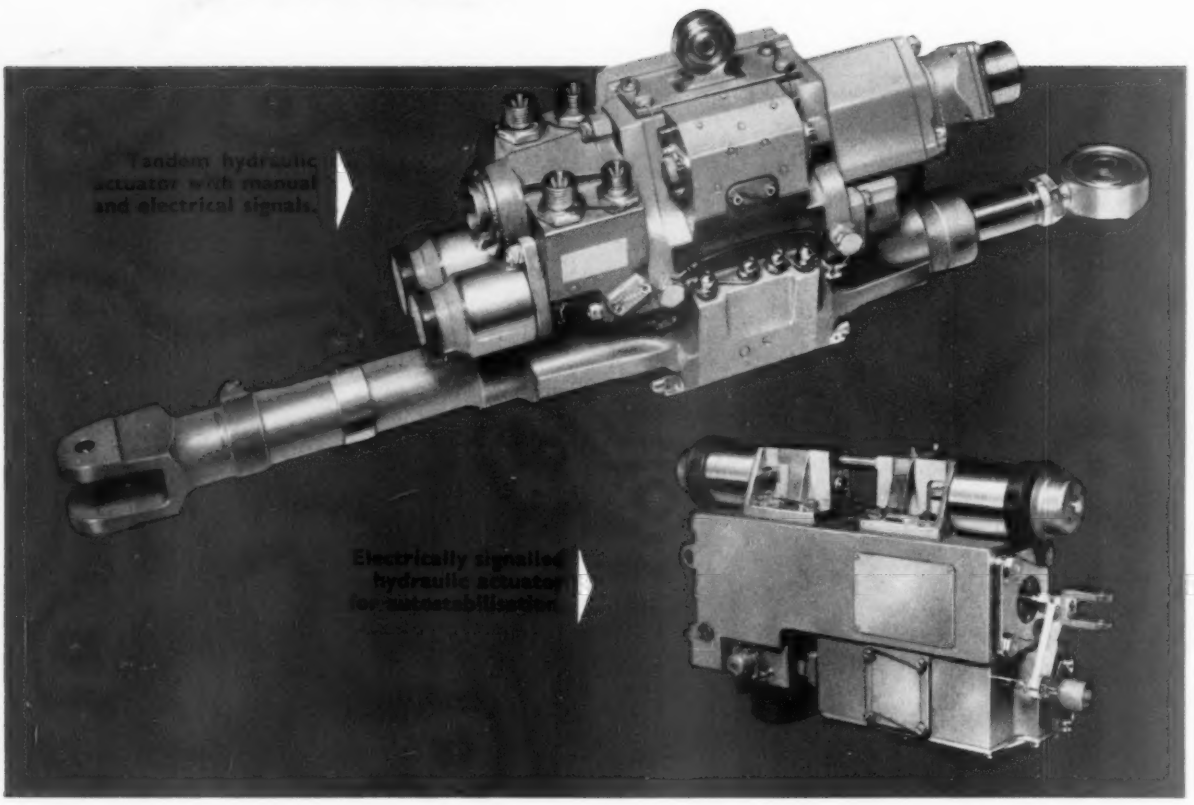
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